UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

3

RESEARCH ABOUT:

1. HERBS, SHRUBS AND VEGETATION IN TURKESTAN
2. GRAZING IN TURKESTAN
3. RESULTS OF GRAZING IN TURKESTAN
4. VARIOUS PLANT MIGRATIONS IN TURKESTAN

2/9

~~BY~~ ALLEN DE CHANY

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S U B J E C T: 3.

D I V I S I O N   O F   F O R E S T   R E S E A R C H

U N I T E D   S T A T E S   F O R E S T   S E R V I C E

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RESEARCH AND TRANSLATIONS:

BY ALLAN DE CHANY

ENGINEER OF FORESTRY

BY SUGGESTION OF DR. WILLIAM R. CHAPLINE,

UNITED STATES FOREST SERVICE

I N D E X

C H A P T E R I.: HERBS, SHRUBS AND VEGETATION IN TURKESTAN.

Paragraph 1.: H E R B S

iblio. 1. The flora, especially the Pharmaco flora of Turkestan, is in every respect highly interesting. There are existing here many floral zones, from steppe-land, to the eternal snow-covered mountain region.

The widely leveled steppe is covered with grayish loss, or plain loss dirt and because of lack of water can not be irrigated; therefore, the steppe is covered with typical Xerophytes, meaning very little in pharmacobotanical respects.

The Ilish sand hills are covered with the same vegetation as the following:

HALIMODENDRON ARGENTEUM

TAMARIX PALLASII

NITRARIA SCHOBERI

POPULUS EUPHRATICA

STELLERA and various types of

CALLIGONUM

The only useful berb is supposed to be the

PEGANUM HARMALA

This plant has a very strong root system and it is used for various purposes by the inhabitants; besides, it is adapted in the modern pharmacy as a light purgative. Little significance is attached to the pharmaco-botanical viewpoint, called by the Russian Geobotanists the "Gray absinth steppe" (Sjeropolynnaja steppe) with the typical flora such as

ARTEMISIA MARITIMA and

KOCHIA PROSTRATA

Here as in most every cultivated zone are to be found areas covered with

GOEBELIA ALOPECUROIDES

The natives have to fight seriously against this very resistant weed; but in pharmaco-chemical respects, it has quite a status, as all of its parts contain a very strong ingredient, by test usually bitter. If only one seed is broken and mixed with the flour, the whole bread becomes bitter. Eating a piece of such bread results in indigestion, dizziness and vomiting. Neither do the domestic stock enjoy this plant.

In the steppe of the Syr-darja region, besides the

GOEBELIA

ALHAGI CAMELORUM and

CERATOCARPUS ARENARIUS

occurs a very useful plant, namely the

"PSORALEA DRUPACEA"

It has a significantly pleasant odor and by distillation, the product becomes an aromatic substance.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Where irrigation is possible, many other basic types of the steppe vegetation are abundant. In low and moisty places are occurring the following:

GLYCYRRHISA URALIENSIS

" GLABRA

" ASPERRIMA

These latter plants are widely distributed and their roots represent a significant market value. In the cultivated regions

HAPTOPHYLLUM SIEVERSEI

is widely distributed, from which an aethercal oil is extracted. It grows in companionship with

LAVATERA THURINGIACA

" CRUPINA VULGARIS and

ALTHEA NUDIFLORA

[illegible]

In some regions where the moisture permits it, Mesophytes and Hydrophytes thrive and are generally represented by several species growing together in communities, such as the following:

EPHILOBIUM

LITHRUM VIRGATUM

PHRAGMITES COMMUNIS

NEPETA NUDA

ALTHEA OFFICINALIS

Herewith are occurring significant masses of

APOCYNUM VENETUM

the plant with strong fibers, from which the natives make rope and cord. A large portion of the steppe is occupied by salty (sodium chloride) swamps - covered with typical Halophites in the form of bushes and grasses, such as various species of the following:

TAMARIX

ANABASIS

ARTIPLEX

CAMOHOROSMA

STATICE

SALSOLA KALI

NITRARIA SCHOBERI and

HALOXYLON AMMODENDRON in tree form.

The pharmaco-botanical aspects of the salty swamps and steppes are of very slight value. The only noticeable fact is the distribution of several species of

GLYCERRHIZA

Furthermore, little interest is evoked by the steppe-land covered with gravel. The vegetation in this locality is starving, although interesting as a species per se. Here and there, it is covered with

ACANTHOPHYLLUM PUNGENS or

ARNEBIA DECUMBENS

Typical of this kind of steppe flora are the

CONVOLVULUS FRUTICOSUS and

HYPECOUM PENDULUM

The stony mountain slopes are generally covered with various types of the following:

SEDUM

SAXIFRAGA and

ZIZIFLORA CLINOPODIOIDES

These "Labiateae" are similar in their habitat to the

THYMUS SERPYLLUM

Having a strong spicy aroma

Some weeds occurring in gardens are offering a pharmaco-botanical distinction, notably the following:

SOLANUM NIGRUM

" DULCAMARE

BRYONIA ALBA

PHYSALIS ALKEKENGI

HYOSCIAMUS NIGER

In community with the

URTICA CANNABINA

is to be found the herb

HYOSCIAMUS PUSILLUS

In the southern part of Turkestan, especially on the slopes of Kopat-Dhag, occurs the

HYOSCIAMUS RETICULATUS

which contains).24 per cent alkali.

It is worth mentioning the herb

CYNANCHUM ACUTUM (family Asclepiadaceae).

This plant usually represents the properties of Asclepiadaceae and Apocyneae, containing a thick, milky sap, of the nature of rubber.

In contrast to the steppe, stands the mountain zone, Semiretschenks. Here, as is natural to the elevation, the moisture is mixed with the atmospheric air, which consequently has an influence on the vegetation.

The Xerophytes are interchanged with the Mesophytes and the character of stand is altered conspicuously. The transition from Xerophytic formation to Mesophytes is achieved gradually. The transfer zone is a typical grassland-steppe. On the eastern ans southern slopes of the extreme spur of the mountains, the Artemisia maratima yet remains, although only in small masses. It is replaced by

ARTEMISIA DRACUNCULUS and

" ABSINTHIUM

Larger masses can be found of the following:

CRUPINA VULGARIS

CENTAUREA RUTHENICA

TURGENIA LATIFOLIA

DODARTIA ORIENTALIS

The ravines of these spurs of mountains are covered with a very luxuriant vegetation. By their imposing growth the following are very remarkable:

LIGULARIA MACROPHYLIA

EREMUS ALTAICUS

Furthermore, LATIRUS TUBEROSUS and single species of ATRAPHAXIS MUSCHKETOWI exist, which hints at the connecting zone of steppe, in which occurs a mass of

DICTAMUS FRAXINELLA

a very useful domestic medicine.

Adjacent to the aforesaid zone, is the (deciduous) hardwood forest region, constituted mainly of the following shrubs:

CRATEGUS MONOGYNA

PIRUS MALUS

BERBERIS HETEROPODA

POPULUS TREMULA

ACER SEMENOWI

SPIREA LASIOCARPA

The composition of the grass field registers as follows:

DICTAMUS FRAXINELLA

LIGULARIA MACROPHYLLA

" ALTAICA

SOLIDAGO VIRGAUREA

[illegible]

<u>SENECIO SONGORICUS</u>

<u>BUPLEURUM AUREUM</u>

<u>CODONOPSIS OVATA</u>

<u>POLYGONUM POLYMORPHUM</u>

<u>INULA HELENIUM</u>

There are occurring in great masses the following:

<u>EREMURUS ROBUSTUS</u>

<u>ASPIDIUM FILIX-MAS</u>

In this zone is found a very interesting species of <u>Ferula</u>, namely,

<u>FERULA COPALENSIS</u>

All parts of this plant have an odor identical to that of the French turpentine. The plant itself, grows on the southern slopes of the mountain ravine at the entrance of little Almatjinks, by Medeo, not far from Wjerny. There, at about 6000 feet elevation, this plant grows in immense masses. Its bulbous root weighs about six pounds. The top of the bulb is covered with very coarse cheffy hairs. The root is often fork-like; and when injured, a milky sap runs out, smelling like French turpentine.

By distillation in water fumes 2-2.3 per cent transparent oil can be obtained, which soon turns greenish and smells as turnip. When the oil is at a standstill, it becomes colorless

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

and the odor uniform.

The zone of hardwood (deciduous) forest is closed with a poplar belt. The outer part begins to mix with the zone of conifers, which is composed mainly of the tall and slender Tian-Shan spruce (Picea Schrenkiana). There grows abundantly, the Sorbus tianschanica, whose berries are considerably larger than those growing in Europe. The Tian-Shan spruce is not rich in turpentine, but the oil extracted has a very remarkable, mild odor. Mixed in this coniferous forest occurs, furthermore, the following:

ACONITUM EXCELSUM *1

" TIANSCHANICUM *2

The latter is closely related to the

ACONITUM NAPELLUS *3

The Aconitum Tianschanicum occurs on the Plateau of Karkara - Santas Pasz - in the vicinity of Prschewalsk.

The tubers are morphologically and anatomically identical with that of the Aconitum Napellus and the Khirgiz population uses it as a medicine in serious poison cases.

At the extreme part of the coniferous belt the vegetation becomes poorer and poorer, exactly as is the case in the Alpine regions.

** 1-2: (Not cultivated in the United States).
* 3 : (This is cultivated in the United States).

The offspring is midget-like (small) and the color of its flowers uncertain. The typical species of this zone are as follows:

ERIGERON AURANTIACUM

CORTUSA MATTHIOLI

ANTOXANTHUM ODORATUM

ANEMONE NARCISSIFLORA

DRABA ALPINA

THALYCTRUM ALPINUM

VIOLA BIFLORA

" ALTAICA

PAPAVER ALPINUM

and near to the snow belt is found

PRIMULA NIVALIS

DRYADANTHE BUNGEANA

THYLACOSPERMUM RUPIFRAGUM

As we see, the flora in pharmaco-botanical respect is not very interesting. The last-mentioned zones moves into the mountain flora near the city of "Wjerny". In very few places is there fashioned a distribution of plant formations, so significant as those in this locality.

A strong impression is created by the wide Plateau of Karkara, which is found along the way between Prschewalsk and Dscharkent, at about 7000 feet elevation. In the middle of July, the Plateau offers a most luxuriant Alpine meadow (grassland), signified by its rich colorfulness; and on the gayly-hued floor are occurring the dark orange colored flowers of

PAPAVER ALPINUM and

ERIGERON AURANTIACUM

Here and there are some groups of

ACONITUM TRANSHANICUM

Associated with

" EXCELSUM

Larger masses of LEONTOPODIUM are mixed in with

INULA RHIZOCEPHALA

Behind Karkara on the Ssantas Pass, just as on the mountain slopes is to be found great masses of

VERATRUM ALBUM

In some places near Isemirelschenk occurs

JUNIPERUS SABINA

In the ravines of Borochudsir, not far from Dscharkent

PRUNUS ARMENIACA

occurs in large quantities.

Very many important medical herbs can be observed in Ssemiretschensk.

Cultures of RHEUM PALMATUM variety TANGUTIC thrive well, just as the various RHEUM species and as far as the climate is suitable RHEBARB plants also.

Large masses of PAPAVER SOMNIFERUM are offering a fair development.

Likewise, such satisfactory results are obtained with the following:

RICINUS COMMUMS

ARACHIS HYPOGAEA

CANNABIS INDICA

FOENICULUM OFFICINALE

SESAMUM ORIENTALE, etc.

blio 2. The study herein contains results, composed of a collection from the principal botanical gardens, containing all the Turkestan herbs.

The worked material, consists of eight (8) collections, representing eight hundred (800) herbs, which are used on various occasions by Mohammedan doctors, and are on sale in the open barazrs. Three (3) out of the eight (8) collections, were determined through [illegible]. A. Dubjansky, and B. A. Fedtchenko.

The work is made up mainly for the purpose of determining the source, or base-plant of the herbs. It is not always possible to determine the entire parts, especially the roots and (gum) resin.

By revision of the researched material, identical objects are presented, forming a collection of three hundred and seventy-two (373) different herbs, of which three hundred and thirty-nine (339) belong to plants, six (6) to animals, and twenty-seven (27) to minerals. Fatty substances and aetherical oils are lacking in this collection.

H E R B S   I N   T U R K E S T A N

In the table below are included all species occurring:

1.	Abrus precatorius Leguminosae	:	14.	Alpinia officinarum Zingiberaceae	
2.	Acacia catechu Leguminosae	:	15.	Althaea rosea Malvaceae	
3.	Achillea micrantha Compositae	:	16.	Althaea rosea variety nigra Malvaceae	
4.	Achillea santolina Compositae	:	17.	Alyssum homalocarpum Cruciferae	
5.	Aconitum napellus variety tianschanicum Ranunculacea	:	18.	Anacyclus pyrethrum Compositae	
6.	Acorus calamus Aroideae	:	19.	Anamirta cocculus Menispermaceae	
7.	Adiantum capillus Polypodiaceae	:	20.	Anchusa italica Borraginaceae	
8.	Adonis aestivalis Ranunculaceae	:	21.	Anethum graveolens Umbelliferae	
9.	Aegle marmelos Leguminosae	:	22.	Apium graveolens Umbelliferae	
10.	Alhagi camelorum Leguminosae	:	23.	Arctium majus Compositae	
11.	Allium porrum Liliaceae	:	24.	Areca catechu Palmae	
12.	Aloe species Liliaceae	:	25.	Aristolochia longa Aristolochiaceae	
13.	Alpinia galanga Zingiberaceae	:	26.	Artemisia cina Compositae	

27. Asparagus sarmentosus
Liliaceae

28. Astragalus adscendens
Astragalus florulentus
Leguminosae

29. Astragalus vrachycerae
Leguminosae

30. Astragalus corrugtus
Leguminosae

31. Astragalus Sieversianus
Leguminosae

32. Bambusa species
Gramineae

33. Berberis heteropoda
Berberidaceae

34. Boswellia Carteri
Burseraceae

35. Brassica special
Cruciferae

36. Cannabis sativa
Variety indica
Urticaceae

37. Capparis spinosa
Capparidaceae

38. Carthamus tinctorius
Compositae

39. Carum copticum
Umbelliferae

40. Carum nigrum
Umbelliferae

41. Carum sogdianum
Umbelliferae

42. Cassia absus
Leguminosae

43. Cassia acutifolia
Laguminosae

44. Cassia angustifolia
Leguminosae

45. Cassia Fistula
Leguminosae

46. Celosia cristata
Amaranthaceae

47. Centaurea depressa
Compositae

48. Cichorium intybus
Compositae

49. Cinnamomum Cassia Blume
Lauraceae

50. Cinnamomum citriodorum
Lauraceae

51. Citrullus colocynthis
Cucurbitaceae

52. Cocos nucifera
Palmae

53. Commiphora Mukal
Burseraceae

54. Commiphora opobalsamum
Burseraceae

55. Conium maculatum
Umbelliferae

56. Coptis anemonaefolia : Berberidaceae :

57. Cordia myza Borraginaceae :

58. Coriandrum sativum : Umbelliferae :

59. Corylus avellana Betulaceae :

60. Cotoneaster nummularia: Rosaceae :

61. Crocus Korolkovi Iridaceae :

62. Crocus sativum : Iridaceae :

63. Croton tiglium Euphorbiaceae :

64. Cucumis sativus : Cucurbitaceae :

65. Ciminum cyminum Umbelliferae :

66. Curcuma longa : Zingiberaceae :

67. Curcuma zedoaria Zingiberaceae :

68. Cuscuta monogyna : Convolvulaceae :

69. Cuscuta planiflora variety approximata : Convolvulaceae :

70. Cydonia vulgaris Rosaceae

71. Cyperus pertenuis Cyperaceae

72. Cyperus rotundus Cyperusaceae

73. Daemonorops draco Palmae

74. Datisca cannabina Datiscaceae

75. Datura stramonium Solanaceae

76. Daucus carota Umbelliferae

77. Delphinium semibarbatum Ranunculaceae

78. Dianthus crinitus Caryophyllaceae

79. Dorema sabulosum Umbelliferae

80. Echium amoanum Borraginaceae

81. Elaeagnus hortensis Elaeagnaceae

82. Elettaria cardamomum Zingiberaceae

83. Embelia ribes Myrsinaceae

84. Entada scandens
Leguminosae

85. Equisetum ramosissimum
Equisetaceae

86. Eremurus special
Liliaceae

87. Eruca sativa
Cruciferae

88. Ervum lens
Leguminosae

89. Eugenia caryophyllata
Myrtaceae

90. Euphorbia pygmaea
Euphorbiaceae

91. Euphorbia resinifera
Euphorbia

92. Ferula assa foetida
Umbelliferae

93. Ferula Karelini Bunge
Umbelliferae

94. Ferula sumbul
Umbelliferae

95. Foeniculum vulgare
Umbelliferae

96. Fraxinus sogdiana Bunge
Oleaceae

97. Fumaria Vaillentii
Papaveraceae

98. Garcinia Morella
variety pedicellata
Guttiferae

99. Gentiana Olivieri
Gentianaceae

100. Glycyrrhiza glabra
L. & G. uralensis
Leguminosae

101. Helychrysum arenarium
Compositae

102. Helicteres isora
Sterculiaceae

103. Heracleum Lehmannianum
Umbelliferae

104. Holarrhena Antidysenter
Apocynaceae

105. Hyoscyamus special
Solanaceae

106. Illicium religiosum
Magnoliaceae

107. Illicium verum
Magnoliaceae

108. Indigofera argentea
Leguminosae

109. Inula grandis
Compositae

110. Ipomoea hederaceae
Convolvulaceae

111. Ipomoea turpethum
Convolvulaceae

112. Iris Alberti
Iridaceae

113. Juniperus pseudosabina
Pinaceae

114. Kaempferia galanga
Zingiberaceae

115. Lactuca scariola
Compositae

116. Lallemantia iberica
Labiatae

117. Lallemantia Royleana
Labiatae

118. Laminaria special
Algae

119. Lavandula dentata
Labiatae

120. Lawsonia inermis
Lythraceae

121. Lepidium perfoliatum
Cruciferae

122. Lepidium savitum
Cruciferae

123. Linum usitatissimum
Linaceae

124. Lycoperdon special
Fungi

125. Mallotus philippensis
Euphorbiaceae

126. Malabaila secacul
Umbelliferae

127. Malva rotundifolia
Malvaceae

128. Matricaria lamellata
Compositae

129. Myristica fragrans
Myristicaceae

130. Nardostachys Jatamansi
Valerianaceae

131. Nelumbium speciosum
Nymphaeaceae

132. Nepeta bracteata
Labiatae

133. Nigella sativa
Ranunculaceae

134. Ocumum basilicum
Labiatae

135. Schinum canum
Labiatae

136. Onosma echioides
Borraginaceae

137. Opoponax chironium
Umbelliferae

138. Orchis special
Orchidaceae

139. Pachyma cocos
Fungi

140. Paeonia special
Ranunculaceae

141. Parmelia kamschadalis
Lichenes

142. Peganum harmala
Rutaceae

143. Phaseolus mungo
Leguminosae

144. Phyllanthus emblica
Euphorbiaceae

145. Physalis alkekengi
Solanaceae

146. Pimenta officinalis
Pyrtaceae

147. Pimpinella anisum
Umbelliferae

148. Pinus Gerardiana
Pinaceae

149. Piper cubeba
Piperaceae

150. Piper longum
Piperaceae

151. Piper nigrum
Piperaceae

152. Pistacia lentiscus
Anacardiaceae

153. Pistacia Khinjuk
Anacardiaceae

154. Pistacia vera
Anacardiaceae

155. Plantago
Plantaginaceae

156. Polyporus officinalis
Fungi

157. Portulaca oleracea
Portulacaceae

158. Prunus insititia
Rosacea

159. Prunus mahaleb
Rosacea

160. Psoralea corylifolia
Leguminosae

161. Pterocarpus santalinus
Leguminosae

162. Punica granatum
Punicaceae

163. Roemeria rhoeadiflora
Papaveraceae

164. Rubia tinctorum
Rubiaceae

165. Ruta Sieversii
Rutaceae

166. Salvadora persica
Salvadoraceae

167. Salvia hypoleuca
Labiatae

168. Santalum album
Santalaceae

169. Sapindus Mucorossi
Sapindaceae

170. Semecarpus anacardium
Anacardiaceae

171. Satureja hortensis
Labiatae

172. Sesamum orientale
Pedaliaceae

173. Seseli indicum
Umbelliferae

174. Smilax lanceaefolia
Liliaceae

175. Solanum nigrum
Solanaceae

176. Solenanthus species
Borraginaceae

177. Strychnos nux vomica
Loganiaceae

178. Tagetes patula
Compositae

179. Tamarindus indica
Leguminosae

180. Terminalia bellerica
Combretaceae

181. Terminalia chebula
Combretaceae

182. Tribulus terrestris
Zygophlyyaceae

183. Uncaria gambier
Rubiaceae

184. Veronia anthelmintica
Compositae

185. Xanthoxylum Bungeanum
Rutaceae

186. Xanthoxylum Rhetsa
Rutaceae

187. Zingiber officinalis
Zingiberaceae

188. Ziziphora tenuior
Labiatae

189. Ziziphora tenuior
Labiatae

190. Zizyphus mauritiana
Rhamnaceae

191. Larimus maculatus
"Trehala Manna"

192. "Lapis cancrorum"

B I B L I O G R A P H Y   A N D   R E F E R E N C E S

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PARAGRAPH 2: S H R U B S.

Biblio. 1. SAND HILLS WITH PSAMMOPHYTOUS SHRUBS.

The sand hills are the next stage of development of the "barkhan sands". Owing to the chemical composition of the Karakum sands, favorable to vegetation, and to the still more desirable water properties, which make it possible for the barkhan sands not only to close up their water balance at a profit, but even to accumulate underground water with such scanty rainfall as that observed in Karakum, vegetation begins gradually to cover the barkhan sands.

PIONEER PLANTS OF THE BARKHAN SANDS, CHANGING THE LATTER INTO SAND HILLS.

The pioneer plants settling on the barkhan sands have in the first place to reckon with the mobility of the latter. As the barkhan rows with their advancing steep slopes show a height of 8-10 m., a few days of strong wind are sufficient to overwhelm not only the low herbaceous plants, but also the 2-3 m. high shrubs, growing on the borders of the hollows.

The same refers to the vegetation coming in the way of the lateral movement of a part of the barkhan row. In the same way, the fruits and seeds of the plants may be covered up with sand and by the time of germination lie buried under a sand layer several meters thick, through which their sprouts will naturally not be able to grow. On the other hand, in places where the sand is driven away by the wind, the latter, in a few days, will blow bare not only all the short roots of the herbaceous plants, but also a great part of the long roots of big shrubs.

Under such conditions, life in the moving sands is possible only for those of the pioneer plants which show special adaptations to being "covered up" as well as "blown bare", and whose fruits and seeds remain on the surface of the shifting sand.

Among plants of the usual substratum such adaptations are not met with. The pioneers of the flora of shifting sands, settling on the moving barkhans, are endemic psammophytes showing marked biological and morphological adaptations to a life on a moving substratum. The first pioneer of the barkhan sands is the grass

ARISTIDA PENNATA TRIN. variety KARELINI

which represents a psammophyte endemic for the sands of Turkestan. When the shrub has been covered up by sand, rhizomes with long internodes and sharp tips develop from the buds and axils of the leaves. These rhizomes grow quickly through the sand layer and having reached its surface develop a new tuft of leaves and afterwards aerial stems. At the nodes of the rhizome arise long adventitious roots which are especially profuse near the surface where they spread horizontally, in the sub-superficial moisture horizon. These roots are clothed with a continuous cover of sand particles which first are held together by the root hairs and afterwards become cemented. This cover seems to play a role in the blowing bare of the roots, to which, spreading near the surface, they are constantly subjected.

The next of the pioneer plants are the shrubs of the genus Calligonum belonging to the family Polygonaceae. In the southern part of the barkhan range, adjoining the Amu-Daria (from the Afghan frontier to Kerku and Palvart) the species Calligonum Caput Medusae is spread, a shrub of inconsiderable height (1-1/2-2 m.) with a profusely branched crown. Below Palvart, especially at the latitude of Chardjui

and of the stations Barkhany and Karul-kuyu (of the Middle Asiatic Railway), this species is joined by two other pioneers. The first of them, Calligonum arborescens Litw., is a shrub 2-3 m. high, showing the tendency to form a rather thick brush of little branching stems. The second, Calligonum elatum forms a little bushy tree reaching a height of 3-4 m., with marked trunk and a light whitish crown.

The shrubs of Calligonum are covered with thin, green, tough, leafless branchlets. The young growth sticks out of the sand like spare bristles, without retaining the wind, or the sand. The lower parts of the barkhan row move over such growth almost as quickly as in bare places and therefore, Calligonum is not covered up with sand. The high barkhan rows, slowly advancing towards a shrub of Calligonum, gradually cover it up, but the tips of the branches growing more rapidly than they are overwhelmed by the sand, are always somewhat ahead of the latter and stick out on its surface like a dark, green brush.

If the barkhan, which has covered up the shrub, is not large, the shrub begins to grow in all directions, pushing its way to the light through the sand and pervading a part of the barkhan row with numerous profusely branched stems.

When the barkhan row has passed over the shrub, one part of it proves to be bound by the numerous roots and stems of the shrub, which radiate in all directions and show that the whole green surface of such - sometimes very large - mound is formed by the branch tips of one buried shrub.

This intensive growth of the buried shrub may be explained in the first place by its faculty of giving rise to adventitious roots in the parts of the stem covered up by sand. By virtue of this, every branch adds its own nutrition to the general one received from the root system. When the roots buried too deeply die off, such a branch becomes a separate young plant, rooting not far from the surface and, therefore, not suffering from the lack of aeration of the roots, which is evidently the reason why other high plants perish when considerably covered up with sa nd.

The adventitious roots of these species of <u>Calligonum</u> reach a very great length (above 30 m.) and spread chiefly in horizontal direction, keeping near the sub-superficial moisture horizon.

The faculty of giving rise to adventitious roots when covered up with sand is especially marked in the pioneer

Ammodendron Conollyi Bge., the whole genus being psammophytous and endemic for Turkestan.

In the Northern part of the Barkhan range this species is represented by a race forming fine slender trees with silver leaves, drooping branches and clusters of deep purple fragrant flowers. This tree reaches the greatest height observed among psammophytes up to 6 and even 7 m. This race is an excellent pioneer penetrating into strongly moving barkhan sands. The author has observed adventitious roots at a height of over 3 m. from the base of the stem.

Besides the above-mentioned plants, adventitious roots are formed by the arborescent Salsola Richteri (Kerel), a pioneer of second order, and even by the sand saxaul Arthrophytum arborescens Litw., a pioneer of third order.

The structure of the fruits in the psammophytous pioneers is very characteristic. The fruits of Calligonum Caput Medusae (Schrenk) are covered with thick branched bristles, changing them into elastic balls which at the slightest wind roll skipping over the sand, leaving behind the sand particles and therefore, not being covered up by them.

The balls of C. arborescens (Litw.) are somewhat smaller with coarser and less branched bristles. The fruits of C. elatum (Litw.). show long but not thick and little branched bristles.

[illegible]

The fruits of the shrub Smirnovia turkestana (of the family Papilionaceae), which are of different construction, roll over the sand almost as readily. The dry, thin-walled legume, containing but 2-3 seeds not bigger than peas, is swelled almost to the size of a hen's egg.

The fruits of the pioneer "seline" show at their tip, three hairy awns, each of them being curved outwards. This gives the fruit the shape of a tridented anchor which, owing to the elasticity and hairiness of the awns, rolls skipping on the surface of the sand.

The arborescent race of the sand acacia, being a fair pioneer, has long, flat, spirally twisted legumes with one seed, which are driven over the sand just as well as the balls of Calligonum.

How great the adaptability of the psammophytes to life in the shifting sands, is shown by the fact that even the sand sedge, Carex physodes M. B., has solved the problem, difficult for its genus and has formed large (1-1-1/2 cm.) spherical or oval bags, owing to which its fruits roll over the sand when driven by the wind.

Stopping only when the wind ceases and with it the movement of the sand, the fruits of the psammophytes escape the fate of being buried under the sand, remaining on the surface; may germinate and produce sprouts amid the barkhan sands.

<u>However well the pioneers-psammophytes bind the sand</u>, still the strength of the wind, not infrequently, defeats them, blowing away the sand and the plant; even a whole big shrub, lies on the surface of the sand with its underground parts exposed. In this case, a protection against immediate drying are in <u>Aristida</u>; firstly, the dead leaves which do not decay for a long time, and secondly, the cover of cemented sand particles on the roots. In <u>Calligonum</u>, a corky layer develops on the buried stem and on the roots.

Afterwards, the thick shrub <u>Aristida</u> rapidly accumulates sand around it and is soon covered up once more. <u>Calligonum</u> lies on the surface of the sand with its thick heavy green crown. Thus it retains the wind, as well as the sand particles, until it gives rise to adventitious rootlets and, growing from the tips of its branches, continues to accumulate another mound of sand, until it reaches its former state.

The long adventitious roots of <u>Ammodendron Conollyi</u>, growing chiefly in horizontal directions, are covered when blown bare, with abundant young growth which continues the life of the mother plant when the latter falls down and dies off. The same abundant young growth appears on the adventitious roots of the pioneer <u>Eremosparton flaccidum</u> (Litw.)

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(psammophytous genus of the family Papilionaceae, endemic for the sands of Turkestan).

In spite of this astonishing adaptability to being wind-swept and buried, exhibited by the species peculiar to the shifting sands, it may be frequently observed that they are not able to stand the rapid movement of the barkhan rows, and perish, leaving traces in the shape of numerous stumps in different stages of decay, sticking out of the sand.

The settling of the first pioneers binding the sand, immediately shows its influence on the character of the sands, sharply altering their mobility, and gives rise to the natural processes of growing over.

Already 2-3 separate shrubs of Calligonum buried by a barkhan row and having grown through it, destroy its entireness, retaining the whole mass of sands bound by the stems and roots and admitting the progress of the sand only in the interstices between the shrubs. The separate portions of the broken barkhan row broaden laterally in their further progress, lose in height, decrease their velocity and thus become more accessible to plants. The barkhan row is gradually transformed in a series of immobile mounds bound by vegetation, and in separate portions of the row, continuing their progress for some time.

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This moment may be regarded as the last of the second stage of the barkhan sand, after which the sands enter the third stage - sand hills with shrub vegetation. This transition is shown in photo 18 (p. 68).

As the mobility of the sands decreases, the pioneer-psammophytes are gradually joined by other psammophytes showing less marked adaptations to being covered up and blown bare, which may be regarded as pioneers of second order.

To them belongs the arborescent Salsola Richteri Kar.. reaching 3-3-1/2 m in height, Calligonum eriopodum of still taller habit, the semi-shrub Astragalus ammodendron paucijugus (N. Basil) etc. The grass Aristida pennata Trin. variety minor (Litw.), makes its appearance, showing here no features of a pioneer and usually growing in the little exposed hollows between the barkhans.

The spaces between the shrubs are covered with a light growth of the sand sedge, Carex physodes M. B. Its horizontally branching rhyzomes, with a thick network of adventitious rootlets, occupy a layer of sand, up to 20 cm. thick.

The aerial parts of the plant are small tufts of thin leaves, about 16-20 cm. long, and single stems with reddish and brown orbiculate bags surrounding the fruits.

The sand sedge is the most wide-spread plant in the sands of Turkmenistan, occupying $\frac{3}{4}$, 4/5 of the whole acreage, <u>and it is of great importance as a forage plant</u>.

Photo 19 (p.70) shows a grass cover consisting of <u>Carex physodes M. B</u>.

In measure as the processes of growing-over approach the sand hills to a state of considerable solidity, the gradual succession of plant communities begins to take place under the influence of the environmental conditions altered by the plants.

The practical side of this succession consists in the fact that the first pioneers of the moving sands begin to dig off with the decrease of mobility displayed by the sand hills bound by vegetation. This dying off is especially conspicuous when the pioneers are surrounded by a herbaceous cover of <u>Carex physodes M. B</u>. The old shrubs dry up rapidly, while the natural renewal of <u>Calligonum arborescens (Litw.)</u>, <u>Calligonum elatum (Litw.), Ammodendron Conollyi, Eremosparton</u> flaccidum (Litw.), etc., entirely ceases.

Young specimens and especially yound shoots of these species are met with only in places with scanty vegetation and in bare areas where the sand is still shifting. The most susceptible to the growing over of the sands is the pioneer <u>Asistida pennata, Trin. variety Karelini(Tr. and R.</u>)

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It is the first to die off and its brush preserved for several years in the dead state, testifies of the succession of plant communities.

The appearance of vegetal life on the sands is connected with a dimunition of their moisture. With a certain thickness of the vegetation cover, the loss of water caused by the transpiration of the plants begins to exceed water supply. This loss of moisture especially increases with the appearance of a cover of Carex physodes M. B., and the remains of the sub-superficial moisture horizon become exhausted.

At the same time the water supply diminishes, first, because a part of the rainfall does not reach the sand being retained by the vegetation; second, through the decrease of the permeability of the upper sand layer enriched with small particles from the vegetation cover. Thus, instead of the usual accumulation of moisture, the water stores in the sand hills bound by vegetation, begin to be exhausted.

This increasing dryness of the substratum is probably one of the chief reasons of the perishing of the pioneers which establish themselves on moving sand. Evidently of great importance also, is the change in the aeration of the roots, induced by the enrichment of the sand, with small particles making it more compact.

When the herbaceous cover of the sand hills has become thick, owing to Carex physodes M. B., and bare areas may be found only at the summits of the hills and in the most windswept hollows, shrubs which may be regarded as pioneers of the third order make their appearance, such as: Calligonum setosum (Litw.), which is the most widespread shrub of sands which grow over.

Salsola subaphylla (Cam.) and Ephedar strobulacea, which are met with in single specimens and play no important role in the vegetation cover; and, finally, the sand saxaul Arthrophytum arborescens (Litw.), which of widespread and great importance among the vegetation at this stage of the development of the sands. The sand saxaul is a high, leafless shrub, less frequently a small tree reaching a height of 4-5 m., with a diameter of 20-30 cm. It emits small, adventitious roots and is able, therefore, to stand slow covering up by sand; gradually growing through the latter and pushing its brush through sand layers many meters high.[1]

1. NOTE: Near the Repetek Station there are shrubs of the sand saxaul which have reached ahheight of 15-20 m., by gradually growing through the advancing ridges of moving sand.

In order to be propagated by seeds, the saxaul requires a loose surface layer and puts up with a certain shifting of the latter. In sands showing a thick, herbaceous cover and a compact surface, no young shoots of the saxaul are found.

Owing to its facility for growing on sands of different stages, beginning with such as are partly bound by vegetation, which are still loose and in places even shifting up to such as are covered with vegetation throughout, the sand saxaul is the most wide-spread plant of the sand hills of the second period. It occupies the bottom of the hollows, as well as the slopes and even the summits of the hills.

The sand saxaul, as all other psammophytous shrubs, forms no thickets, growing in separate shrubs and occupying by the projections of its crowns, not more than half of the surface.

In the stands of the sand saxaul are interspersed shrubs of Calligonum setosum (Litw.), Salsola subaphylla (Cam.); less frequently Salsola Richteri Kar., and often the semi-shrub, Astragalus confirmans, which is rather good fodder for horses, sheep and camels.

In the herbaceous cover, consisting here of the thick growth of Carex physodes M. B., occur plants very peculiar in their biology, as follows: Rheum Turkestanicum (Janisch), and Dorema sabulosum (Litw.)

Sometimes, Ferula Karelini is met with, having edible root tubers, with a soft, juicy, sweetish, starchy content, which in flavor and size, slightly recall the tubers of Helianthus tuberosus L. These tubers are regarded by the Turkish men as a dainty; and, indeed, in the heat of the summer, when all are dying of thirst, the juicy, savory tubers of Ferula Karelini are very refreshing. This plant is able to stand a certain mobility of the sands and, therefore, it might become a vegetable valuable for the country, in view of its adaptation to the barren sands.

Among old stands of the sand saxaul, at the bottom of hollows, most thickly covered with vegetation and showing a compact surface, usually appear specimens of the saline soil saxaul, whose development leads to the last stage of the evolution of sands - forests of Arthrophytum Haloxylon (Litw.)

This succession is induced by the influence of the sand hill vegetation on its substratum, rendering the upper sand layer more compact and saline.

Ferula Karelini might be grown on such sands where the cultivation of other plants can not be thought of.

PSAMMOPHYTES INDUCING COMPACTNESS AND SALINITY OF THE SOIL.

Under the influence of the developing vegetation, radical changes in the sand sub-stratum take place, showing

themselves in the chemical and mechanical composition of its surface layer and in its water properties. The shrubs of Calligonum, and especially the trees of Arthrophytum Haloxylon (Litw.), cover the sand surface every fall with a layer of assimilating branches from their crown, thus enriching it with

1. Salt solutions which are leached out from them by rainfall; and owing to the scantiness of the latter are not washed out from the surface layer of the sand, and
2. Small soil particles whose number increases through the products of more energetic weathering of the minerals making part of the sand.

GENERAL CHARACTERISTIC.

The saxaul of saline soils, forst appears at the bottom of hollows occupied by the sand saxaul, as the sand in the hollows becomes compact earlier than that on the hills. This saxaul species reaches its highest development in continuous forests occupying peculiar valleys, 2-3 klm. broad and several times longer, situated between sand ridges 10-20 m. high. The summits of these ridges are occupied by sand shrubs Calligonum setosum and sometimes Salsola Richteri, usually with an admixture of sand saxaul, and show an herbaceous cover of Carex physodes.

On the highest summits, especially near large wells, sometimes bare areas are met with. The whole of the remaining space is covered exclusively with Arthrophytum Haloxylon, almost without admixtures of other shrubs. On the slopes, its growth is slightly stunted and it does not reach very large dimensions; but in the valleys the shrubs are thick and tall, not unfrequently attaining the shape of trees, 4-6 meters high and 1/2 m. in diameter.

In exceptional cases single trees are met with showing a height of 6 m. and almost one meter thick. The virgin forests are filled with dry brush-wood which by the number of shrubs and by their total mass exceeds that of the living shrubs and trees; sometimes 3/4 of the wood found in these forests consist of dry fallen logs.

Thin stands are characteristic of the saxaul of Karakum. On the slopes, the density is usually about 0.i-0.2 at the bottom of the valleys it reaches 0,4 and sometimes up to 0,5. Continuous stands are not met with in Karakum. The thickest forest seen by the author near the well Dzengish displayed a density about 0,6.

The herbaceous cover in the forest of Arthrophytum Haloxylon is rather poor. The open spaces between the shrubs of the saxaul are covered with a scanty growth of the sand

sedge. In places where the soil, under the influence of the saxaul, shows great compactness, this cover becomes very thick and in some places even dies off. Not unfrequently it is replaced by the small annual grass Schysmus arabicus supplying a certain amount of forage, and by the annual Statice spientu, which in some places forms a continuous cover.

Only where the sand has been loosened by the burrows of rodents, or by heavy pasturing of sheep, develop the annual grasses Bromus tectorum and Triticum orientale, which supply good fodder.

Under the crowns of the saxaul, where the soil is impregnated with salts leached from the dead cover, a peculiar vegetation is found.

Here occur Atriplex dimorphostegium relished by sheep, the annual Kochia latifolia, Kochia odontophera, Suaede Lipskyi as well as Matricaria lamvellata and Popaver pavonium.

The propagation by seeds of Arthrophytum Haloxylon in the forests with compact soil is inconsiderable. More abundant young growth is usually met with on the slopes of the ridges bordering the valleys, where the sand is somewhat less compact.

Sufficiently abundant young wood may be found on small

areas, from a fraction of a hectare to several hectares large, and within the limits of these areas, it is usually of the same age. The coeval groups are usually separated by considerable intervals of age, 5-10 years.

As the seeds of Arthrophytum Haloxylon show a fair germinating power, it is evident that the appearance of young shoots depends on a series of external favorable conditions, as for instance, autumn rains which are of rare occurrence in these places; or, the passing of a flock of sheep after the rain: or, of Antilope subgutturosa (which are numerous in this region), trampling the seeds into the surface of the sand softened by moisture.

Thus the increasing compactness of the sand surface in the saxaul forest, creates rather unfavorable conditions for the propagation by seeds of Arthrophytum Haloxylon. These conditions are somewhat improved by the burrows of rodents which loosen the sand in areas up to one hectare large and then move on to another place. Such areas are usually characterized by the abundant growth of young saxaul trees.

The increasing salinity of the soil induced by Arthrophytum Haloxylon scarcely influences the propagation of the tree, as the latter is able to renew itself on much more saline soils in the lowlands of Kelifsky Uzboi.

The moisture conditions of the forest of Arthrophytum Haloxylon, growing in the valley-like depressions, are evi-

dently constant, as the roots of the saxaul avail themselves of the underground waters found at a depth of but several meters. The saxaul forests covering the sand hills depend probably on the moisture received from rainfall, as the moisture stored up during the stage of the "barkhan sands" must have been exhausted already by the predecessors of the saxaul of saline soils - the psammophytous shrubs and the sand saxaul.

The question whether the forests of Arthrophytum Haloxylon having changed the substratum to a degree excluding the possibility of further renewal of the saxaul, die out in turn, requires additional investigations, which are carried on by the Repetek Sand Station. In his investigation of the saxaul forests of Karakum, embracing the by far greater half of these forests, the author has nowhere found any signs of such dying out. The above-mentioned weakened renewal from seeds, observed in old saxaul forests with very compact sand, may lead at the most to a still thinner stand. The saxaul forests will renew themselves for all that through the agency of Antilope subgutturosa and rodents, to say nothing of sheep, as several hundred of seedlings per hectare during one decennium are sufficient to keep up the usual (rather moderate) density of its stands.

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Thus the forests of Arthrophytum Haloxylon replacing the thickets of the sand saxaul, must be regarded as the final stage of the described type of Karakum sands, permanently constant under the present conditions.

SPREAD OF THE SAXAUL OF SALINE SOILS.

The low valleys to which the sand saxaul is usually peculiar show a rather level plain lined at a depth of 1-2 m. with a stratified gypseous bed, 8-10 and even up to 15 m. thick. The layers of gypsum 5-10 cm. thick, consisting of small crystals having grown together, alternate with layers of gray sand up to 5 cm. thick. Under the gypseous bed, the underground waters are found, in gray sand.

In the North and in the North-East it borders on the zone of high sand hills covered with the growth of sand saxaul. This zone in turn borders on the barkhan range of the Amu-Daria. The stands of the sand saxaul have suffered greatly from the inhabitants of the Amu-Daria valley, which come here for their supply of wood. Not unfrequently they even penetrate with their caravans of camels into the forests of Arthrophytum Haloxylon, which they greatly devastate.

To the South and the South-East of the wells Tutly and Gheogcha begin high sandy hills with the predominance of the sand saxaul.

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Half way from well Tutley to well Kizyl-dja-baba the saxaul of saline soils entirely disappears, being replaced by the sand saxaul which grows here even in the hollows and depressions. The southern outskirts of the sand saxaul forests are much exhausted by the inhabitants of oasis Merv, whom they supply with wood.

In the West, the forests of Arthrophytum Haloxylon are exhausted and in places even utterly devastated by constant cutting down since the construction of the Central Asiatic railway.

Before the War, the forests within a strip of 30 klm. from the rail-road were proclaimed preserves, but the measure was taken too late, when the forests had already greatly suffered. At the present time, the above-mentioned strip of forest is once more much devastated. In result, the saxaul forests near the railroad have not only been cut down, but the stumps and thick roots have been grubbed up.

Only at 40 klm. from the railroad, may saxaul forests, consisting of larger trees be found. The best saxaul forests stretching between the wells Tutley, Gheokcha and Nedervelent, where the fallen logs had been cleared away during the years of the war, having fairly recovered during the last nine years of rest and have produced considerable additional growth.

Virgin forests with the fallen logs unremoved begin at 80 klm. from the station Uch-Adji. To the East of these the saxaul forests cease altogether, as the sandy hills, to which they are peculiar are replaced here by a sandy-clayey plain.

Thus the region where saxaul forests have been preserved up to now, occupied but a limited acreage measuring about 50 klm., from West to East, and considerably less from North to South. As to the acreage actually under saxaul forests scattered over the narrow valleys, it scarcely occupies the tenth of the region.

THE SUPPLY OF FUEL AND THE DANGER OF ITS IRRATIONAL EXPLOITATION.

Owing to the large dimensions of the saxaul trees which exceed all other kinds of vegetation found in the sandy tracts, as well as the large amount of fallen logs in the saxaul forests, the latter yield a rich supply of wood (40 and even 50 tons per hectare). They are thus a valuable resource of the desert supplying excellent fuel much prized in the woodless region.

The exploitation of the saxaul forests requires, however, much caution. The denudation of the sand by depriving it of its trees, accompanied by a loosening of the upper compact layer, may lead to a secondary deflation, and the sands which

for centuries have been lying under their cover of saxaul forests, may be induced to form barkhans once more.

A secondary deflation 1st, excludes the possibility of renewal of the saxaul forests as Arthrophytum Haloxylon does not grow on shifting sands; and 2nd, rather quickly brings the immobile sands of the final stage back to their original condition, of shifting barkhan sands whose progress may threaten the railroad, as is already the case near the station Uch-Adji, and other ones.

Taking into consideration the thin stands, the small areas occupied by the separate saxaul forests (from 20 to 40 klm.), as well as their being scattered all over the region, it would seem the most expedient to transport the wood in packs by caravans of camels.

Up to 1918, the station Uch-Adji used to store up in this way every year about 1-1-2 million poods of wood. Only dry trees and fallen logs were taken for the purpose.

The lumbering question with regard to South-Eastern Karakum requires prompt regulating measures. The devastation of the 30 klm. broad forest strip along the railroad, which in places has led to the ready possibility of secondary deflation, must be stopped. The necessary wood supply should be taken in the East of the railway, where the saxaul forests, pretty exhausted by lumbering during the war,

have had time since 1918 to recover and even to produce a certain amount of dead trees.

With moderate exploitation, in taking only the dead trees and fallen logs, the saxaul forests of Karakum may supply the local population with fuel without losing the faculty of renewal.

A more intensive utilization of the Karakum saxaul forest, with the construction of railway side branches, whose rentability would necessitate the cutting down of great numbers of living trees, would be rather dangerous under the conditions of Karakum.

It must be kept in view that the ecological conditions of development of the saxaul in forests are rather specific and that the principal questions of its biology (rate of growth, conditions of reproduction by seeds or offshoots) are still insufficiently studied. Up to now there exist no methods of determining the age of the saxaul, without which an exact valuation of the saxaul forests, indispensible for the drawing up of a rational plan of forest management, becomes impossible.

Under these conditions, the utilization of living saxaul trees will lead to such an exhaustion of the forests that their renewal will become impossible and their acreage will decrease at a still higher rate than is the case now.

Intensive exploitation of the saxaul forests will lead to their utter disappearance and may easily induce secondary deflation, bringing us back to barkhan sands. Thus the most productive stage of development of the sands would be changed into the least productive one.

THE NECESSITY OF INTRODUCING PRESERVES FOR THE SAXAUL FORESTS AND OF STUDYING THE LATTER.

The saxaul forests whose world-spread is confined to the Russian and Chinese Turkestan, are endowed with the exceptional faculty of developing in deserts with very scanty rainfall (from 200 m. to 100 m. and less, per annum) and with soils from pure aeolian sand to salt spots. Our saxaul forests are the only forests in the world, occurring in typical or noxious deserts and the saxauls of Karakum, growing under conditions of exceptional dryness and on thick layers, must be regarded as the most perfect type of them.

No wonder that in view of the rapid devastation of the saxaul forests in Karakum, the most authoritative scientific institutions and societies of U. S. S. R. are concerned in the speedy inauguration of preserves consisting of areas of typical saxaul forest in good state, in spite of the resolutions and regulations voted by above institutions with regard

to the saxaul forests in the environs of Repetek, no preserves have been singled out as yet.

The above exposed scheme of the natural evolution of the sands refers to the most wide-spread type of the Karakum sands, to which belong, 1st the barkhan range adjoining Amu-Daria from the Afghan frontier to Chardjui; 2nd, the sandy hills, from their Southern limit, the sandy-clayey plain, to the Central Asiatic Railway between the stations Karayl-kuyu and Uch-Adji.

The railway is naturally but a conventional limit and the sands continue to the North-West of it, evidently, on a considerable expense. In spite of their origin through the weathering of different mother rocks (on the greater part of the area - alluvial deposits, and on the smaller part - tertiary sandstone), the sands show an identical evolution which may probably be explained by their contemporary origin.

The type of sands is evidently of later origin than the other sands of South-Eastern Karakum, as they still show remnants of their initial state of development, - "sands in statu 'nascendi'", though these remnants cover but insignificant areas and are of rare occurrence.

The early stage of the development of sands, the "barkhan sands", still occupy about one-half of the whole area of

the type; the middle stage - the "sandy hills" with their vegetation of psammophytes occupy about one-third of the area. As to the final stage - "forests of Arthrophytum Haloxylon" (or more correctly, "sandy hills with forests of Arthrophytum Haloxylon"), they occupy a still smaller acreage. The two other types of the sands of South-Eastern Karakum, the "sandy-clayey plain" and the "sandy ridges" - are found only in late stages of development.

THE SANDY-CLAYEY PLAIN.

The sandy-clayey plain consists of slightly stratified sandy soil alternating with rather thick clayey layers. It shows on the whole a level surface covered with a thin sand layer of aeolian origin. The vegetation consists of sand shrubs scattered over a continuous cover of Carex physodes M. B.

The limits of the sandy-clayey plain are given approximately on the schematic map. The Western limit of the plain has been traced presumably, in view of the lack of data. The area of the sandy-clayey plain is about ten thousand square klm., which constitutes about a quarter of the whole sand desert of Karakum.

The thickness of the aeolian sand covering the clayey ground, fluctuates from 0 to 3-4 meters.

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The sand is yellow-colored, very fine, and shows a considerable amount of sand dust. With the exception of small areas of newly accumulated sand, it bears the character of almost compact old aeolian sand. The mechanical analysis of a sample taken at a depth of 4 cm. at 5 klm. to the South-West of well Kerli, shows the following results: The vegetation is to a considerable degree determined by the thickness of the aeolian cover. In places not covered with sand, the sandy-clayey plain shows the character of "takyrs" which are either perfectly bare, or are covered with scanty vegetation. This <u>vegetation consists of ephemers developing on low sand hillocks, several inches high, retained on the surface of the "takyr"</u>. Among the <u>ephemers</u> prevail the following:

<u>ASTRAGALUS TRABULOIDES</u>
<u>" CORRUGATUS</u>
<u>KOELPINIA LINEARIS</u>
<u>SCOZONERA HEMILASIA</u> and
<u>AGROPYRUM ORIENTALE</u>

which supply very scanty fodder for the sheep.

If the sand layer is less than one meter thick, <u>psammophytes</u> are usually missing.

The principal plants here are Artemisia turanica growing in large separate bushes and Artemisia maritima. The greatest density is one plant per square meter. The interstices between the plants are usually occupied by Carex physodes, sometimes with the admixture of the annual grasses Bromus tectarum, Agropyrum orientale and of some Salsolaceas.

The thickness of the sand layer being one meter and somewhat above, the wormwood is replaced by Salsola arbuscula, and not unfrequently by the shrub Zygophyllum artiplicoides, with the admixture of the semi-shrub Salsola rigida. The interstices between the plants are occupied by a rather thick cover of annual grasses and Carex physodes. The sand under Salsola arbuscula is still more compact and even slightly cemented at the surface.

A still thicker layer of aeolian sand is covered already with sand shrubs, Salsola Richteri, Calligonum setosum and the arborescent Salsola subaphylla.

On the northern borders is found saxaul (that of sandy, as well as that of saline soils) in form of shrubs. The large interstices between the shrubs are occupied by Carex physodes forming a continuous grass cover and developing here much better than between Salsola arbuscula and Artemisia.

The most characteristic feature of the sandy-clayey

plain is its well marked plain relief so little peculiar to other parts of Karakum. Photo 31 (p. 114) shows the general aspect of relief and vegetation of a typical area to the South-West of well Kerli.

The herbaceous cover is represented by Carex physodes with the admixture of Bromus tectorum and Poa bulbosa. Of shrubs, Calligonum setorum is prevalent; sometimes occur single specimens of Ammodendron Conollyi, a race differing from the slender trees of Repetek by their short habit up to 1,5 m., a branched crown, shorter legumes, and by its being found on compact sand.

In places where the aeoleon sand is the thickest, as in depressions in the clayey ground, sometimes secondary deflation develops called forth by roads and the heavy pasturing of sheep.

Only remnants of more compact sand in shape of pillars are found in such places, usually under the crowns of shrubs. Figure 33 (p. 116) shows such remnants of sand near well Khaldyr. On the sand loosened by deflation grows the pioneer Aristida pennata variety Karelini (on the left hand side of the photograph).

The sand loosened by deflation usually forms long narrow sand ridges stretching in the Northern part of the plain to the E. S. E. These ridges are up to 4 m. high and show

a bare surface on which are scattered small shrubs of Aristida and sometimes of Calligonum, Caput Medusae and Salsola Richteri.

THE NORTHERN BORDER OF THE FOOTHILLS OF THE HINDU-KUSH.

Of shrubs, there are met with in great numbers Astragalus Ammodendron confirmans (Freyn.) N. Basil, less frequently Calligonum setosum Litw., and Calligonum microcarpum Borszez., rarely Calligonum eriopodum Bge. The herbaceous cover consists of Carex physodes M. B., of the grasses Bromus tectorum L. and Agropyrum orientale L. and of the usual species found on sands that are grown over: Delphinium Camptocarpum F and M., Papaver pavonium Schrenk, and Arnebia orientalis L., which do not occur on the slopes of the hills covered with fine compact soil. Less frequently than on the summits of the hills, grooves from deflation occur also on the slopes where they are perceptible from afar owing to the ring of psammophytous shrubs surrounding them.

Of the local trees, Populus prunnosa and especially Populus eufratica would answer the purpose. The latter, being a psammophyte (besides the sands, it grows on silty alluvion), is able to stand burying, making its way to the surface through a layer 7-10 m. thick.

It equally stands being blown bare, developing abundant offshoots on the exposed adventitious roots, as may be seen in figure 64 (p. 198 a).

The species of Morus stand being covered up fairly well and emit long adventitious roots as may be seen in figure 46 (p. 166) but without offshoots from these roots.

A brush effectually binding the sand when the latter encroaches on a submerged valley (or under conditions of possible irrigation), is the Tamarix, a widespread common dweller of saline clayey soils. Even under the conditions of intensive covering up, the Tamarix rapidly grows through the sand and pushes its tips on to the surface, where it grows even more vigorously than before, which evidently may be explained by an abundant development of adventitious roots.

Especially valuable are the species of tall habit, as for instance Tamarix Androssowi Litw., sometimes forming shrubs amid the barkhan sands, which reach a height of 7-8 m. and above 20 m. in diameter. The species of short habit, as the common Tamarix Pallasii develop a very thick brush on the sand mounds accumulated and bound by them and are equally very valuable in resisting the encroachment of the shifting dunes.

The most difficult is to check the progress of the leaders of the barkhan range. In view of the high rate at which they

advance, the binding of the sand must take place simultaneously in different directions.

At the foot of a steep slope advancing towards the field must be planted cuttings of Tamarix, of tall habit, as well as seedlings of Populus eufratica Oliv. and Morus. The whole is irrigated by an "aryk". On the summit of the high sand ridge are placed portable protective hurdles made of brushwood and herbaceous plants. In fall, these hurdles are placed near the crest of the small barkhan formed under the influence of the South-Eastern winds, whose crests have the direction N 60 - 70^{o} and which on the whole advance towards the kishlak zone.

The hurdles prevent the small barkhans from reaching the ledge of the ridge and from rolling down to the field. In spring, when the winds have changed and the barkhans move in opposite direction, that is, away from the ledge of the ridge, towards the sandy tracts, the mechanical protection is removed, to let the sand be driven away by the wind and is kept until autumn.

To support the work of the hurdles, it is expedient to plant the shelving slope turned away from the kishlaks, with cuttings of Calligonum Caput-Medusae Schrenk. and Salsola Richteri Karel., and with shrubs of Aristida pennata Trin. variety Karelini Trin. and Rupr.

These plantations will retain a part of the sand keeping it off the hurdles, for which reason there will be no need to free the latter from sand in midwinter and to fix them anew. Being situated at a lower level than the summit of the ridge, the plantations will not prevent the summer winds from driving away the small barkhans from the ledge of the ridge.

After a few years, 1st owing to the removal of a part of the sand from the summit of the ridge by the summer winds; and 2nd, owing to the accumulation of sand by the plantations of psammophytes - the summit of the ridge will have been shifted to these plantations, that is, removed from the ledge, which will slacken the movement of the sand down the steep slope.

By the time that the *Tamarix* and *Populus eufratica* *Oliv.* will climb up the slope, growing through the sand, the progress of the sand towards the field will be checked. With a ridge 8-10 m. high this may be expected 5-7 years after the beginning of the work. But already, after 2-3 years, the rate at which the sand advances will slow down and this slowing down will increase progressively with every year.

As in fall the population cuts down *Alhagi* in the transitional zone and *Aristida* in the barkhan zone, laying

bare the sand and loosening it by the time that the "Afghans" set in, which greatly promotes the progress of the sands towards the kishlaks; it is necessary to issue forthwith an edict prohibiting the cutting down of Alhagi and Aristida, as well as of shrubs, within three klm. of the kishlak zone. The pasturing of cattle within this strip must be equally forbidden.

The whole area of small sand hillocks, and a considerable part of the area occupied by middle-sized hillocks, not suited for crop plants, might be used for the cultivation of trees. All hillocks obtained after the preparation of the land for irrigation should be surrounded with trees.

In sands showing small hollows, the bottom of the latter, as well as the lower part of the slopes should be occupied by trees, and Aryks should be conducted into the hollows. The mulberry and Populus Eufratica will most successfully answer the purpose; Elaeagnus is also sufficiently reliable.

With regard to apricots it is difficult to say, whether they will produce satisfactory results, but grape growing in these places may be considered as sufficiently reliable.

Robinia pseudoacacia has prospects for success; unfortunately it is planted nowhere, though it would be very important

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to try this tree in view of its rapid growth and the great value of its wood.

It would be equally desirable to test GledICzia. Ailantus glandulosa may be recommended for its rapid growth and high ability of reproduction.

This tree supplies much fuel, as well as timber for light buildings and fences. It would be expedient to try the Turkestan Populus alba, as well as different species of Ulmus.[1]

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[1] NOTE: On the sands of Repetek, with underground water at a depth of 3 - 4 m., Ulmus grows as a large tree, without being watered.

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B I B L I O G R A P H Y A N D R E F E R E N C E S

1. "The Sand Desert South-Eastern Karakum Its Natural Regions".
"Herbs, Shrubs and Vegetation in Turkestan".
Sand Hills with Psammophytous Shrubs.
Library of Agriculture. 451 - R 92. Bulletin of Applied
Botany of Genetics, and Plant Breeding, 1928.

PARAGRAPH 3: VEGETATION.

Biblio. 1

"PLANTS OF CENTRAL ASIA".

Investigations of recent years, carried on in many countries and regions of Eurasia, established the exceptional importance of the region enclosed between South-Western Himalaya and South-Eastern Hindu-Kush. It is in these districts of North-Western India and South-Eastern Afghanistan that forms of many field crops of the Old World have originated.

Soft and club wheats are the following:

TRITICUM COMPACTUM

" VULGARE

" SPHAEROCOCCUM

RYE

PEA

LENTIL

VETCHING (LATHYRUS SATIVUS)

BEANS (VICIA FABA)

FLAX

CARROT

BRASSICA CAMPESTRIS

" JUNCEA

They show in this region such a striking concentration of varietal diversity, as may be found nowhere else in the world.[1]

Now the question arose as to what might be found on the northern slope of the Himalaya, at the foot of the Kwen Lun, on the vast expanses of Central Asia, stretching from Pamir and Kwen Lun. It might be naturally supposed that the form-originating process is not confined to the South-Western slopes of the Himalaya mountains, but embraces equally the region to the North of the range. Perhaps the role played by vast Central Asia in this process of origination of forms of cultivated plants was not less.

Such a supposition was made at the close of the XIC century by the well known botanist Solms Laubach who, on the basis of botanico-geographical considerations came to the conclusion that the home of wheat ought to be looked for in Central Asia.[2]

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1. N. Vavilof and D. Bukinich, Agricultural Afghanistan, 1929, Chapter 18. Supplement to the Bulletin of applied Botany, Plant Breeding and Genetics.

2. See the remarkable paper of Sir Aurel Stein - "Innermost Asia". Its geography as a factor in history, Geographical Journal LXV., No. 5, No. 6, 1925, with appended geographical map of Sinkiang.

It is at the foot of Kwen Lun and Tian Shan, that ancient agriculture is concentrated and the possibility of finding elements here of the primary origin of the forms of cultivated plants is not excluded.

Still, before the problem was concretely studied on the spot, all solutions could be approximate only and of a conjectural character. It will be easily understood, therefore, that the study of Chinese Turkistan - the Sinkiang province of China, immediately adjoining Northern Himalayas and embracing the ancient oases of agriculture Kashgar, Yarkland, Khotan, as well as the oases on the Southern slope of the Tian-Shan - was of surpassing interest to us.

Even a cursory survey of the hypsometrical map of Chinese Turkestan is situated at the Northern foot of the Himalaya mountains, near Pamir and along the Southern slope of the Tian-Shan. It is separated from Eastern and Central China by the desert Taklamakan. The distribution of the agricultural oases of Kashgaria is very clear on the map drawn up by Sir Aurel Stein.

During the last decade, numerous English, German, Swedish, Russian, American and Japanese expeditions have intersected Chinese Turkestan in different directions, chiefly in search of historical records of ancient art.

In the beginning of our century (1910), the Department of Agriculture in Washington sent Frank Mayer, the well known investigator of cultivated plants, to Sinkiang. He travelled through Sinkiang in the winter of 1910-1911, (October, 1910 - March, 1911) and his route was through Irkestam, to Kashgar and Yarkand, from where he went to Ak-su and reached Kuldja. The scientific results of his work, however, have not been published. As far as known to us, he confined himself to the collection of interesting seed samples and cuttings of cultivated plants. Only the "Inventory of Seeds" published by the U. S. Department of Agriculture, Washington,[1] informs its readers with Meyer's work, giving a circumstantial list of plant materials supplied by him.

Among poplars of Sinkiang, tamarisks, willows, different shrubs of the dry regions of Sinkiang (*Spirea, Lonicera, Caragana, Reaumuria, and Ribes*), by wild apricot and apple trees of Tian-Shan, and numerous melon varieties of Sinkiang. In the same number of "Inventory", the obtainment of *Apocynum Hendersoni Hook* and *A. venetum L.*, is mentioned.

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1. U. S. Department of Agriculture. Bureau of Plant Industry. Bulletin No. 242. Seeds and plants imported. Inventory No. 27. Washington, 19212.

The author of the present paper undertook last summer (July-November, 1929), conjointly with Dr. M. G. Popov and Dr. V. V. Dubiansky, an expedition to Sinkiang, embracing the region of Central Asia from Kashgar to Urumchi. The expedition investigated the districts Uch-Turfan, Urumchi, and Kuldja.

Seed specimens were collected also in Yarkand and Khotan. Moreover, a selective investigation of the most important agricultural districts of Kazakstan and Kirghizstan, was carried out as well as of some districts of western and Eastern Siberia, and of the Far East. The purpose of these investigations was to ascertain the diversity shown by the cultivated flora of Central Asia. A rich material of varieties (about 5,000 seed samples) has been collected. In late fall, 1929, we (Vavilov), entered upon the study of the East Asiatic centers of the origin of cultivated plants (Corea, Japan and Formosa). What results gave the comparative botanical and agronomical investigation of the crops of Central Asia?

It has been most firmly established that, in spite of existing suppositions (Solms Laubach), Central Asia shows no features pointing to independent beginnings of agriculture and of an independent genesis of cultivated plants in this country. On the contrary, it shows indubitable traces of having borrowed its crop plants chiefly from Western Asia

and Asia Media, partly from India, as well as from Central and Eastern China.

1. A highly important fact for determining the role played by Central Asia established by our expedition, is a very limited, small number of field crops found in ancient agricultural regions of Sinkiang, if compared to neighboring, principal cities, such as South-Western Asia and Eastern and Central China. This statement becomes especially evident for grain Leguminosae and cereals. The cultivation of peas. lentils, beans (Vicia Faba), vetching (Lathyrus sativus) is practically almost unknown to Sinkiang, even to its largest, densily populated oases at Kashgar and Yarkand. The chickpea (Cicer arietinum), a common plant in Asia Media is sown here on a very small scale. Lentils, beans and peas are grown in noticeable quantities, chiefly in Zungaria and in the region of Urumchi.

To the West and South-West of the Pamirs, on the heights of Kashgaria, peas, beans, vetching and chickpeas are crops of the most common occurrence.

It must be noted that the conditions of the Sinkiang province are by no means unfavorable to the cultivation of the above-mentioned crops. Persian clover (Trifolium resupinatum), a common forage crop in Afghanistan beyond

the Hundu-Kush rye, (Secale cereale) is not only a most noxious, widespread weed, not unfrequently supplanting winter and even spring wheat, but sometimes occurs even as a cultivated plant, here in Sinkiang, it does not exist even as a weed. Notwithstanding a most careful search among the crops of winter wheat, the author has not met with even a single rye plant.[1] The cultivation of hulled barley, a most common crop in the high mountain regions of South-Western Asia, is almost unknown in the vast oases Kashgar and Yarkand. Hulless barley occurs only in Zungaria.

In short, it may be said that in comparing the diversity of the field crops found beyond the Himalaya mountains, as well as the North and East of Pamir, with that of Fergana, Persia and Afghanistan, a decrease in the number of crops must be stated, though the ecological possibility of cultivating them admits no doubt.

2. In Sinkiang the attention of the botanist-agronomist is involuntarily drawn by the absence of many wild growing relatives of cultivated plants, common in South-Western Asia. The species of Aegilops, namely,

AEGILOPS TRIUNCIALIS
" CYLINDRICA
" SQUARROSA
" CRASSA

1. Rye has been found by M. G. Popov only in the region of Shikho in Zungaria.

of common occurrence in Asia Media, are entirely missing in Kashgaria and Zungaria. Secale sereale, so common in Asia Minor, in the mountains of Persia, does not occur on the slopes of Tian-Shan, Kwen-Lun and the Eastern Pamirs.

Wild barley, Hordeum spontaneum (Koch) whose stands are thickly covering the foothills of Hindu-Kush and those of Transcaucasia, here disappears. Neither wild growing Ervum orientale. Boise, nor Ervum Ervilia. L have been recorded; Lathyrus cicera, as well as the wild growing Allium Cepa and Allium Sativum are missing. Even Andropogon halepensis a common weed of Asia Media, is not met with. All these wild growing relatives of cultivated plants have been left in the West, beyond the HinduKush.

3. The influence of the Himalaya, Pamir and Tian-Shan as mighty barriers and filters, becomes still more conspicuous in the varietal diversity, the number of botanical varieties, by which the most important Linnean species of cultivated plants are here represented. This number is much less in Sinkiang than in the neighboring Northern India, Fergana and Afghanistan.

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Soft and club wheats are represented by some ten varieties. They show a marked prevalence of Tr. vulgare v. Erythrosperum. Korn and Tr. vulgare v. ferrugineum A l. in the crops of winter wheat, of the pubescent, white grained Tr. vulgare v. pseudo-turcicum Vav. in those of spring wheat. In the Northern region, the Northern slope of Tian-Shan, less frequently on the Southern one, Tr. compactum may be met with in cultivation, showing inconsiderable diversity. As to the neighboring Afghanistan, the author found there in 1924, 60 varieties of soft wheats (tr. vulgare) and 50 varieties of Tr. compactum. leaving out of consideration innumerable smaller systematical forms. Moreover, a great number of these varieties proved endemic for Afghanistan. The species of Tr. durum, Tr. turgidum, as well as allied representatives of the 28-chromosomes group of cultivated wheats, are entirely missing in Sinkiang. Barley is rare in Sinkiang and is chiefly represented by Hordeum vulgare pallidum. Ser.

Even rice, one of the most important crops of Chinese Turkestan, shows no great diversity; varieties with brown and black glumes, with black awns, common for North-Eastern

Afghanistan, do not occur in this province. In the oases Kashgar, Yarkand, and Khotan prevail Asiatic coarse-awned races indubitably coming from South-Western Asia. The typical Chinese awnless cultivated forms with white glumes are predominant in Urumchi and Kuldja.

The chickpea (Cicer arietinum), showing a great diversity in India[1], is poorly represented in Sinkiang. The number of grape varieties in Sinkiang is not great, if compared to the Middle Asiatic Republics, and according to the investigations of M. G. Popov, evidently coming from neighboring Fergana.

Still poorer is the assortment of fruit trees, apples, pears Elaeagnus hortensis, Prunus divaricata, even apricots so rich in varieties in Fergana. The carrot, so multifarious in Afghanistan, where 26 botanical varieties have been singled out, the black and the purple carrot[2] inclusive, is represented in Sinkiang by uniform yellow forms.

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1. Agricultural Afghanistan L. G. Howard, A. Howard, G. Kahn A. R. Some varieties of Indian Gram (Cicer arietinum L.) Mem. of the Dep. of Agriculture in India. Bot. Ser. Vol. VII., No. 6, 1915.

2. V. J. Mackevicz. The carrot of Afghanistan. Bull. of Appl. Botany, V. XX, 1929.

The other crops require a more detailed study, by sowing the collected seed samples, but their relative uniformity is doubtful. The same uniformity of varieties and of field crops, is observed in Kazakstan, Kirghizstan and Siberia, or in Central Asia, in a wide sense. The spring rye of Eastern Siberia is uniform; and the "Local" wheat of the Amur province shows striking uniformity.

4. The next fact established by our expedition, is still more striking. It testifies not only a decrease of varietal diversity, but also points to the selection here of recessive forms, a peculiar phenomenon characterizing the periphery of the principal areas of plants and animals, as well as isolated localities.[3]

The recessive forms usually disappear rapidly under conditions of co-existence with dominant races; here, however, in this geographical isolator, they are preserved and reproduced in a pure state. The oases Kashgar, Yarkand, and Khotan - the most ancient regions of agriculture in Kashgaria - arrest the attention of the investigator first of all by their original flax.

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3 N. Vavilov. Geographical regularities in distribution of the genes of cultivated plants. Bull. of applied Botany. Vol. XVII., 1927.

Varieties with white flowers with broad petals are less frequent. As known from the investigations of Tine Tammes, white flowered forms, with narrow petals are recessive with regard to the normal blue colored forms and races with ordinary petals. Recessive characters are white colored, narrow petals, with yellow and white anthers. In Kashgaria, flax is cultivated for oil and is evidently represented by a practically very valuable group of races. The outer habit of the white flowered, narrow-petaled Kashgaria flax is rather peculiar and in the period of bloom, it differs sharply from common flax.

Sesamum indicum of Kashgaria is equally exclusively white-seeded with light bluish flowers. This is once more a recessive form. As the investigations of our experiment stations of the seed samples forwarded to us, in 1927, from Kashgaria by the Consul General of USSR, M. F. Dumpis, have shown that this is the earliest group and is of great value for our most Northern regions of Sesame cultivation. Black-seeded forms have been found by M. G. Popov only in Turfan. They are entirely missing in Kashgar, Yarkand, Khotan and Ak-su. It is a black-seeded race of short habit,

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1. Blue colored flowers with narrow petals have never been found by us, though we have repeatedly searched for them. This must be attributed evidently to the linkage of the gofered narrow-petaled flower with white color.

with trifoliate leaves suggesting Japanese Sesame. This race was probably introduced into the country from China.

For other cultivated plants of Sinkiang province the manifestation of recessives is equally common. Carrots with yellow roots, sometimes even showing a tendency to whiteness, are prevailing. Mustard (Brassica juncea), known under the name of "kchi", is a widely spread crop plant chiefly with white-yellow seeds, which is once more a recessive feature. Among the fruits, nectarine peaches with a smooth skin (recessive) are predominant. Of frequent occurrence in Sinkiang are nectarines (local name "togach") of a bright dark-red color. Sometimes white nectarines (ak-togach) are met with.

Barley as well as rice are chiefly represented by varieties with light chaff.

It is worth mentioning, that Alhagi camelorum - the wild camel thorn of Kashgaria, is frequently characterized by light-colored flowers showing a marked flavone color, thus sharply differing from the more bright red colored forms of Asia Media.

Thus, in a certain degree new formations make their appearance, a development of a peculiar form originating process, in the sense of singling out recessives, manifests itself.

Not infrequently such recessives, as for instance early races, white seeded forms are evidently of practical value.

The relatively small number of crop plants, restricted in comparison to that of South-Western and Eastern Asia, the absence of wild relatives, the varietal uniformity, and the presence of a great number of typical recessive forms - testifies the absence of an autochtonic cultivated flora in Central Asia, and points to its introduced, secondary character. Central Asia has no independent cultivated flora of its own.

Thus, the Himalaya, Pamirs, Hindu-Kush act as mighty barriers, as a wall separating Central Asia from the chief centers where the forms of cultivated plants have originated. The genesis of a series of cultivated plants of South-Western Asia, is geographically strictly locslized at the foot of South-Western Himalaya and South-Eastern Hindu-Kush to the West of the Pamirs. Only fragments of the varietal riches of cultivated plants have been able to penetrate through the hardy accessible mountain barriers of Central Asia.

A floristical investigation of Sinkiang, carried out by M. G. Popov - has established the striking poverty of the species diversity in Kashgaria, and the absence of any

independent process of species originating.[1]

In comparing the varietal and specific diversity of the cultivated flora found in Central Asia with that of South-Western and Eastern Asia, the constituents of the present Central Asiatic cultivated flora, in a wide sense, may be distinctly established.

THE INFLUENCE OF SOUTHWESTERN ASIA

As may be judged from our comparative-botanical investigations in Southwestern Asia, the field crops of Sinkiang are chiefly represented by plants coming from South-Western Asia, as follows:

WHEAT (TR. VULGARE AND TR. COMPACTUM)
BARLEY (PHASEOLUS AUREUS PIPER
CHICKPEA (CICER ARIETINUM L.)
FLAX (ERUCA SATIVA)
WATERCRESS LEPIDIUM SATIVUM L.
FENUGREEK (TRIGONELLA FOENUM GRAECUM L.
ALFALFA (MEDICAGO SATIVA)
COTTON
SAFFLORA

All these field crops have evidently found their way to

1. See M. G. Popov. Between Mongolia and Iran (in print).

Sinkiang from South-Western Asia. The rice of Kashgar and Yarkand differs little from that of Fergana and probably has been introduced from Soviet Turkestan or from Northern Afghanistan. The spicy plants of Sinkiang are the following:

CORIANDER
DILL (ANETHUM GRAVEOLENS L.)
FENNEL
CUMIN (CUMINUM CYMINUM L.)
AMMI COPTICUM L.
ANISE (PIMPINELLA ANISUM L.)
NIGELLA SATIVA, etc.

They are adventive of the South-West. Part of the cucurnits have come the same way. The same partly applies to a series of vegetables (carrot, turnip, onion - Allium Cepa - and garlic, Allium Sativum).

The whole assortment of grapes, as well as the apricot, Prunus divaricata, the pomegranate, the almond, the fig-tree - have evidently penetrated into Chinese Turkestan from Fergana. This becomes especially manifest in comparing the varietal diversity of these plants, found in Kashgaria, with that of Asia Media.

Thus it is from Asia Media (Fergana) that the chief flow of forms has moved into Chinese Turkestan and into the

more Northern and Eastern parts of Central Asia.

THE INFLUENCE OF CHINA

The influence of the East Asiatic centre on Central Asia, is equally marked. Thus the truck gardens of Kashgaria and Mongolia (investigated by the expedition of the Institute of Applied Botany in 1923) testify the influence of China.

Original Chinese stem lettuce (Lactuca), entirely unknown in South-Western Asia, is cultivated on a large scale in the truck gardens of Sinkiang, for the sake of the edible thickenings of its stem. The local name of this plant is "ussun".

Long-shaped cucumbers (Cucumis chinensis), extremely small-seeded melons (Cucumis chinensis), different varieties of the cowpea, Vigna Catjang, Engl. (Vigna sinensis, Engl.), sometimes with very long pods up to half a meter in length. Chinese-Mongolian radishes in their diversity of the truck-gardens in Central Asia, up to the Kashgaria inclusive.

Moreover, the truck gardens of Sinkiang, Kirghizstan, Siberia and the Far East of USSR are very frequently under the care of Dungans (a Chinafied group of the population of Central Asia) Chinamen, or Coreans.

The influence of China makes itself especially felt in the diversity of the truck crops. Even the technique of their cultivation in Sinkiang, mirrors the influence of China. The truck gardens are conspicuous by their neatness, by intensive cultivation, utilization of every foot of land, wide application of fertilizers, and diversity of crops.

As to the field crops, the Eastern influence manifests itself first of all in Panicum italicum and millet. These two cereals stand high in the estimation of the nomads for their few requirements, drought resistance, and relatively high productivity. For the Corean and the Chinaman foxtail-millet (Panicum italicum maximum), is a most valuable cereal serving to prepare his gruel. The Cossacks and the Kirghiz, value it as forage for their cattle. Only a small amount of seeds is required for seeding purposes. Both these crops are characterized in Central Asia by a relatively great varietal diversity. The Chinese Panicum italicum maximum with large spreading panicle, shows transitions to P. italicum moharicum, of Kirghizstan and Kazakstan; approaching by its type a spike-shaped panicle. Both plants are certainly adventive of Eastern Asia where their varietal multifar-

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iousness is concentrated. The diversity of millet Panicum mileaceum increases towards Mongolia. The numerous samples of Panicum italicum collected by us in Corea and in the Island Kiu Siu, in Japan, reveal that the form originating process of this crop is obviously concentrated in South-Eastern Asia.

The soybean sometimes met with in cultivation in Central Asia, is obviously an East Asiatic plant. Its genetical basis is Manchuria, Northern China, and Corea where the diversity of its characters, its genes, is concentrated. Soja usuriensis occurs in the Amur province as a noxious weed, and sometimes as a wild growing plant. It is represented by small growing forms with pods dehiscent at maturity. It is interesting to note, that even in the Amur province the Corean soubeans - the vanguard of this crop - display a striking diversity with regard to size of pods, shape of seeds, color of seeds and pods and earliness, which points to their proximity to the principal center of the origin of forms.

In distinction of Kashgar and Yarkand, the rice of Semirechye, as well as of the districts Urumchi and Kuldja, betrays the influence of the East, not of the West of Asia. Dissimilar to Turkestan rice, this crop is here chiefly represented by awnless Chinese varieties, or by

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varieties with thin flexible awns and a slightly marked nervation of the flowering glumes; differing sharply from the coarse rice of Asia Media. These cultivated forms show a distinct connection with China. In Semirechye, as well as in the districts Kuldja and Urumchi, rice is chiefly grown by the Dungans. In the Far East, where rice cultivation has made its appearance recently, along with the Coreans, extremely early Japanese varieties are grown.

These are certainly highly cultivated varieties, embodying the continuous work of the primitive plant breeder. As the cultured European has selected awnless forms of soft wheat and oats, and grows them chiefly at the present time, even so the field husbandman of the South-East of Asia, who owing to the density of population, has attained a high degree of cultivation and has bred awnless forms of rice and barley.

According to the data of V. E. Pissarev's expedition of 1923, agricultural Mongolia grows typical Chinese short-awned hulless barley on a large scale. Hulless barleys have evidently reached Urumchi, through the agency of Chinamen.

The opium poppy grown in considerable quantity in the foothill regions of Central Asia draws the attention of the investigator by its extraordinary diversity in regard to color of the corolla, size, shape and color of the capsules,

shape and structure of the seeds and shape of the leaves. The flowering poppy of Kirghizstan, Kazakstan, Zungaria, surprises by the brightness and diversity of color and shape of its corolla.

Forms with bright purple-colored capsules are frequently met with in Zungaria. From this point of view, the opium poppy of Persia and Afghanistan, investigated by us in 1916 and 1924, is very different in its uniformity, its chiefly light-colored corolla and seeds. The legend that the opium poppy has been brought to China by the Arabs, evidently needs thorough revision.

The Chinese opium poppy, if compared to that of Afghanistan and Persia, is very multifarious; many dominant characters are found here, and it is not without probability that the chief ancient center where the forms of this plant have originated, will be found in China. The periodic strict prohibition to cultivate the opium poppy in China, makes it difficult to establish precisely the chief regions of the origins of forms. In any case, the poppy growers of Central Asia have received the crop from China.

The buckwheat (Fagopyrum esculentum) sometimes met with in cultivation in Zungaria, and represented chiefly by Pink-flowered races - is also adventive of Eastern Asia.

Thus millet, Panicum italicum, the soynean, rice, the opium poppy, inclusive, - the principal field crops of the agricultural regions of Central Asia - show distinct traces of having been borrowed from Eastern Asia.

The fruit trees of Central Asia show traces of a double influence. The basis of fruit and grape growing in Kashgaria is formed by varieties from Fergana. Orchards are few; fruit and grape growing are but of minor importance. But already in the orchards of Kashgaria, there may be found typical representatives of East Asia. The Japanese plum Prunus Simoni Carr. with large red or yellow fruits, is of frequent occurrence. Sometimes the East-Asiatic small-fruited Prunus tomentosa Thunb. with fruits suggesting cherries is met with.

The influence of the Eastern pear Pyrus sinensis Lindl., with characteristic awnlike projections along the margin of the leaf, is undoubted. The famous Kuchar pear of Kashgaria, belongs to Pyrus sinensis. Not infrequently, in the markets of Kashgaria, the large-fruited Zizyphus sativa Gaertn., imported from China - this typical representative of South-Eastern Asia - may be met with. The large-fruited mulberry Morus nigra, is equally adventive, of eastern Asia; it is possible that the origin of the common Morus alba is ultimately the same.

In agricultural Siberia, adjoining Central Asia, the influence of the East is more marked. Under the rigorous climatical conditions of Irkutsh, on the Amur, the common European varieties of the apple (Malus pumila) and pear (Pyrus communis), plums and grapes are unable to grow.

They are frost-killed even by an ordinary winter. The aborigene cultivated plants of the Ussuri region, having arisen under the severe conditions of Eastern, and even North-Eastern Asia, thrive in Siberia. In spite of its acerb taste and low quality, Pyrus usuriensis Maxim., is an edible fruit and in common use in Blagovestchensk, Irkutsk, and even still further to the North. Malus baccata-pumila have become recurrent. Usurian prunes fill the (numerous) orchards of the Amur province. This is most valuable material for crosses with European and West-Asiatic species and will doubtless become the source of Northern fruit growing, not only for Siberia, but also for the European part of USSR. Very interesting also is Vitis usuriensis Rupr., small black grapes, sometimes cultivated in the Amur province and grow there in a wild state. The forests of the island Hokkaido in Japan are full of these grapes. In fall, the red leaves of the vines entwining the coniferous trees, form effective landscapes in Japan.

The above mentioned endemics of North-Eastern Asia have, properly speaking, undergone only the beginnings of the influence of man. They are usually propagated by seeds taken from

wild growing individuals. Their multifariousness is great but up to now has had very little investigation.

The influence of India on Kashgaria may be traced on Momordica Charantia L., sometimes called here Indian cucumber. Being grown in Chinese truck gardens, it is especially relished by Indian merchants. The small-fruited forms of Momordica observed in Sinkiang, differ but little by their type from the Indian forms collected by us in Kandahar and Kabul in Afghanistan.

The autochtonic crops of Central Asia are few, but still such ones may be found. Of the field crops the first to be mentioned is hemp. All over Northern Tian-Shan, on its slopes, in the valleys to the North of it, wild growing hemp is of common occurrence. The waste lots of the town Jarkand, in Kazakstan, are covered with thick stands of hemp. It grows on the ridges of fields, not infrequently forming broad borders along the roads.

In ravines, on forest skirts, on marshy ground, on waste land near the villages - weed hemp is the commonest of plants. As a weed it reaches the provinces Irkutsk, Omsk, up to the Amur. Wild hemp is usually not utilized by the population, but sometimes its fiber serves for the manufacture of ropes. Its utilization is especially extensive in the Altai. Wild growing weed hemp is represented, as a rule, by shattering

forms, with a "horse-shoe" at the base of the fruit, with seeds of different size, up to the dimensions of the cultivated large-seeded form.

It is not improbable that somewhere, in places with a settled population, for instance near Minussinsk, wild hemp could become a source for cultivation. E. N. Sinskaya has been able to trace in the Altai all phases from typical wild hemp up to its cultivated forms.[1]

We admit that the introduction of hemp, as of a wild growing plant characterized by a vast area stretching from the South-East of European USSR, to the Pacific, has taken place simultaneously, as well as at different times, in different regions. It may as well have taken place in the agricultural districts of Central Asia.[2]

Of the wild relatives of cultivated plants, Cichorium Inthybus is frequently met with, especially on the Northern slopes of Tian-Shan. But scarcely has it been introduced into cultivation, as no indication of that has been found.

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1. E. N. Sinskaya. Bulletin of Applied Botany, 1926.

2. N. Vavilov. Studies on the origin of cultivated plants. Bulletin of Applied Botany, 1926, Vol. XVI., No. 2.

The wild carrot Daucus carota subsp. Carota L; Thellung grows abundantly on waste land, on forest skirts, as a weed. There is no reason, however, to suppose that it has been introduced into cultivation. The cultivated carrot is here indubitably of an adventive character. The area of the wild carrot is known to us, to stretch from the Atlantic to Central Asia.

Exceptionally interesting are the wild apples found in the mountain regions of Central Asia. Alma-Ata (formerly Verny) means - the town of apples. In the gorges of the Tian-Shan near Alma-Ata, a great diversity of wild apples (Malus pumila Mill.), may be observed. They form a whole cycle of links from typically wild, eneatable, small, acerb apples, to fairly cultivated, comparatively large, sweet ones. Some of the apple trees positively offer themselves for cultivation. In the apple groves near Alma-Ata, there may be found forms with red, yellow and white-colored fruits; with fruits of elongated shape; as well as with round, flat, segmented fruits; small and large ones.

This diversity deserves the most careful pomological study. Similar apple groves are known in Lepsinsk. It is very probable that some of these wild growing apple trees

have been transplanted into orchards, and have given rise to some varieties. In any case, one finds here still growing, groves of wild apple trees, which permits close approach to the problem of the proof of origin of cultivated apples. Moreover, these wild growing forms will have a value for the future breeding of apples.

During his expedition to Tian-Shan, in March 1911, Frank Meyer paid special attention to the wild growing apples found here. In "inventory of seeds" of the U. S. Department of Agriculture, Washington, a detailed characteristic of the wild apple trees of Tian-Shan is given. Meyer remarks upon the value of these forms for hybridization, with a view to breeding drought-resistant, hardy varieties, especially from high altitudes (7,700 feet). The wild apple (Malus pumila) shows a vast area stretching from the Pyrenees to Tian-Shan. Its diversity is great in the Caucasus, but there small fruited forms are predominant.

It is possible, and even probable, that the apple tree has been introduced into cultivation at different times and places. Semirechye could be, and probably has been, one of these centers of the genesis of the cultivated

apple tree, though it is situated on the periphery of the chief area of the apple tree.

The wild apricot (Prunus armeniaca) of Semirechye is very interesting. Stands of it are not infrequently found in the gorges of Tian-Shan. We have observed it in the mountains between Frunze and Alma-Ata. Its diversity with regard to stone, taste, shape and dimensions, is rather great. Undoubtedly some races of it are fit for cultivation and have been introduced into it. The principal center of the apricot gravitates to Asia Media. Tuan-Shan is the periphery of the area.

Very valuable are the wild Siberian blueberry (Vaccinium uliginosum) with large berries, the bilberry (V. myrtillus), the cowberry (V. Vitis-Idaea), the black-elder tree (Prunus Padus). The latter is used for ornamental purposes, embellishing farms and villages; but at the same time, its fruits, as well as the flour prepared from the dried fruits, is an essential article of food. Cedar nuts are equally an important article of food in Siberia.

The agriculturalist himself, found in Central Asia is not of a uniform technological type. Vast tracts of Central Asia are occupied by a nomadic population, Cossacks, Kirghizes, Buryats, which have but recently engaged in agriculture.

The husbandry of the population living in the oases of Sinkiang (Kashgarlyks), referred by A. Stein to the type of a Momo alpinus, is on the contrary of an intensive, settled type.

The emigrants of China, Chinese and Coreans, as well as Dungans are engaged in vegetable growing, or field husbandry. But still, Central Asia, as a whole, was but a little time ago chiefly the realm of nomads. Even the ancient agricultural regions do not testify of autochtonic cultivation, either by the diversity of crop plants, or by the technics of agriculture, which as well as the agricultural implements, plough (omach), harrow (mala) differ in nothing from those of South-Western Asia (Fergana, Uzbekistan and Afghanistan).

The comparative study of the agricultural regions of Central Asia, positively lead us to establish a geographical localization of the form originating process, in which the forms of cultivated plants of Asia have arisen, fixing it in South-Western Asia, on one side, and in Eastern and Central China, on the other. The formerly enunciated supposition,[1] as to the narrow localization of the primary form originating process of the chief Eurasian cultivated plants, as soft wheat, grain Leguminosae, at the foot of South-Western Himalaya and South-Eastern Hindu-Kush - has received

1. N. Vavilov. Studies on the origin of cultivated plants, 1926, Agricultural Afghanistan, 1929.

full confirmation. South-Western Asia, including Transcaucasia, Asia Minor, Persia, Afghanistan, the mountain regions of Soviet Turkestan and North-Western India, actually represent, according to the investigations of the last decade, the primary world center where a great number of forms of Eurasian cultivated field and truck crops, as well as fruit trees have originated. On the other hand, the investigation of Central Asia leads us to a most careful study of another principal world centre of agriculture, the powerful ancient agriculture of Eastern China, up to now touched so little by the investigators.

As recent American expeditions (Andrews) have shown, Central Asia is a world center in the remote past of the transitional forms of animals, connecting primordial reptiles with the present mammalia.

An abundance of fossil Dinosaurs, Titanotheria, and Belujitheria have been found in this region. In Mongolia and the adjacent parts of China, the origin of the camel and the horse must be sought.

As regards cultivated plants, whose genesis refers to more recent geological epochs, Central Asia, as may be seen from the above stated facts, can not be regarded as the primary base of species formation, even of form origination.

Biblio: 2 "VEGETATION OF THE LAKES OF MIDDLE ASIA."

The Kamyschly-Bach lake plane extends on the right side of the river Syr-Darja, at about 60 Km distance from the Delta.

The vegetative life of the lakes and surrounding territories, depends greatly upon the river which is connected with them by a system of arms. By low water stand, two systems can be considered:

1. Kajasdy, - Laj-Kul, - Kamyschly-Bash; and

2. Raim-Kul, Dschalagangasch-Kul.

By high water stand, both systems unite. The distribution of vegetation and the observation of its life activities, are worth attention. The earlier lakes of the system, the "Lake without Name" and the Dschalangash, are especially rich in plants.

In the first named, fourteen species have been found, namely:

TYPHA ANGUSTIFOLIA (in great masses)

PHRAGMITES COMMUNIS (PASSIM) (in shallow water)

and between the principal plant organizations are the following:

SPARGANUM RAMOSUM

SAGITTARIA TRIFOLIA

BUTOMUS UMBELLATUS

HYPPURIS VULGARIS

As an addition MYRIOPHILLUM VERTICILLATUM
In the lake itself may be found the following:

ALISMA MICHALETTII

SCIRPUS LACUSTRIS

POTAMOGETON PUSILLUS

" CRISPUS

" PERFOLIATUS

" PECTINATUS

NAJAS MARINA

In the lake Raim-Kul many species are lacking; but on the other hand there occurs additionally the following:

POTAMOGETON LUCENS (8 species)

NAJAS MARINA

TYPHA ANGUSTIFOLIA

Potamogeton Lucens occurs only near to Iskera. In the "Kamishly-Basch" and "Laj-Kul", many species are missing, but an additional group occurring, is the following:

ZANNICHELLIA PALUSTRIS

SCIRPUS LITTORALIS (13 species all together).

The lake Kajasdy is entirely dry. The lake Laj-Kul has been searched in the direction of Mazar-Kapen and as far as Kajasdy; and from Kara-Buget to SSW, - the contact arm to Phragmites thicket, - namely that vertical to the first mentioned direction.

Approximately every seven English feet (szashen) of depth has been measured and the vegetation chartered.

The transparency of the water goes to the ground; the greatest depth reaches two meters and the entire surface is covered with vegetation. The following zones can be registered:

Along the river, a strip of Phragmites; next to it, "Potamogeton pectinatus" (alone, or plus Chara); deeper, one finds Meriophyllum; and in the deepest section, Ceratophyllum.

The lake Kamyschy-Bash vegetation does not extend deeper than four meters; further there is grayish green mud. In the southern direction, the test of the water is sweetly-bitter and salty, and in the narrow muff of the SW, it is sweet, thanks to the inflowing waters of the Darja, through Kara-Bugut. Along the rivers, Phragmites grow throughout this region, varied with strips of Myriophillum, Ceratophyllum and Potamogeton.

On the river banks of submersions capsules of "Rivularia", especially in the eastern part are growing. The lake, Dschalangash-Kul" has been searched in the direction, from the middle of SW river banks to Mazar Tschigi-baj; and perpendicularly from Kugora to Tawaba. The transparency of water reaches an average of two meters in depth,

the maximum depth being four meters. The ground is an almost flat shell. Phragmites can be found in average up to 2.50 meters in depth. The lake itself is connected by arms with the river and the water especially at its source, rushes rapidly through the reeds. The arms are filled up and so the depth of the lake reaches only two meters and for this reason, the entire ground is covered with vegetation.

The important zones are identical with "Laj-Kul"; only the ground is promiscuously carpeted with the same mass of Myriophyllum and Ceratophyllum, connected, of course, with the life of the lake and consequently with the level ground. Along the rivers, is a very broad strip of Phragmites; and parallel, a strip of Typha and of Scirpus lacustris occurs.

The contact arms of the lake, "Raim-Kul", are functioning at a minimum. The lake has been crossed from the NW to Alul-Iskera and from Berge-Achtumsyk, to the Raimsch water works. The transparency reaches i.5 meters; and the greatest depth 3.45 meters. The mud of the ground is gray, with large plant detritus and the odor of sulphur-hydrogen (Hydrotion).

Investigations prove that since the contact arms have been filled up the surface of the lakes has sunk to one or

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more meters. On account of excessive leveling of lakes, sinkage of ground vegetation has resulted, and evidently the detritus and scantiness of the entire flora (only 8 species occur).

Additional tables are available, which shematically show up the extension of vegetation in the investigated lakes and are attaining a certain legitimacy. It is interesting to note the absence of a zone of species, with broad, floating leaves, behind the strips of Phragmites. Nymphaea, Limnanthemum and Polygonum amphibium, are only sporadically found in the mud and then very lightly, as a result of connection with violent winds that are influencing the proportionate development of vegetation, along the river banks.

Biblio; 3 "VEGETATION OF THE COASTAL SANDS AND DESERTS OF THE KARABUGAS"

The description of the vegetation of the coasts of the Karabugas gulf was made in 1932 by the botanical section of the expedition sent by the former Sand-Desert-Institute, of the Academy of Sciences of the USSR. The investigated region comprised the two sand-banks which separate the gulf from the Caspian sea, the northern coast of the gulf and a part of the southern coast; the salt-works Kyzyl-koop, the Cape Umchal and the well Kosh-aba.

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According to the geological structure, topography and vegetation the region may be subdivided into the following landscape units:

1. The Karabugas sand-banks, covered with different types of sands.
2. The northern and north-western coasts of the gulf which represent the last southern escarpments of the Mangyshlak peninsula.
3. The southern coast of the gulf, formed by the northern borders of the Krasnovodsk plateau.

The vegetation groupings of the Karabugas sand-banks are varied in connection with the various forms of the mezorelief of the banks. The mobile surface of the barkhan sands, which surround the mountain Diuldiul-ata is either comparatively devoid of vegetation, or bears rare separate large bushes of the salinisation. Hillocky sands of considerable size, adjoining the barkhans, are covered with shrubs of psammophytes, among which prevails Ammodendron Eichwaldi. The greater part of the strongly salinised small hillocky sands on the sand-banks are occupied by galophitic shrubs such as the following:

TAMARIX KARELINI

" RAMOSISSIMA

NITRARIA SCHOBERI

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On a small patch of hillocky sands on the sand-bank Karasukut is found Arthrophytum haloxylon; this is the only place here where this plant connected with solonchaks (saline soils) grows on sand-banks; but on the northern and southern coast it is customary.

On the overgrown hillocky sands are also met with wormwood and feathergrass groupings. The depressions of the sand-banks are occupied by solonchaks with Phragmites communis, Glycyrrhiza glabra, Aeluropus littoralis and plants from the genus Chenopodiaceae.

The southern and northern desert coasts of the gulf, having much in common as to vegetative types, however, are each of them characterized by some peculiarities in this respect. On the northern coast are developed Chenopodiaceae complexes, along the valleys, drains and "sors"[1], Artemisia anabasis groupings in the north-western part of the coast, and on the northern coast, - Salsola gemmascens complexes.

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1. Dry depressions with salt efflorescenses.

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CHAPTER II. GRAZING IN TURKESTAN.

Paragraph 1. "The Sand Desert South-Eastern Karakum - its Natural Regions."

Biblio: 1

The sand deserts of Turkestan are of paramount interest to the investigator. They represent a special type of landscape, characterized by relatively rapid developments. The succession of the stages of natural evolution proceeds here at a rate which many times exceeds the rate of development observed in other types of Turkestanic landscapes. The investigator, therefore, finds in the sand deserts a great diversity of separate modifications of the sandy landscape. In comparing these, he is able to establish with a certain degree of probability, the genesis of the separate regions of sand deserts, or of a whole type of analogous deserts; and enables us to reach the highest degree of comprehension not only of the static condition of their properties, but also of their dynamic quality.

The sand deserts occupying large tracts in Turkestan, which in Turkmenistan constitute up to 80 per cent of the whole acreage are of great economical importance, the latter being of negative as well as of positive character.

The sand deserts of Turkestan have been used long since as pastures for sheep, especially the Astrakhan variety, and partly for camels. Of the former flocks in south eastern Karakum, which annually supplied Bokhara with Astrakhan hides up to fifteen million roubles, there remains now but an inconsiderable part.

Practical measures, with a view to developing cattle raising, which is one of the chief means of utilizing the sand deserts, are inevitably confronted with a sad lack of knowledge as regards the resources of forage and drinkwater, the influence of the cattle on the different types of sand, etc.; all these questions require thorough investigation.

The great mobility of the barkhan rows prevents the plants from gaining a foothold on them. Only the bottom of the hollows and the lower parts of the shelving slopes are slightly covered with vegetation which consists almost exclesively of one species Aristida pennata, variety Karelini "seline", a large sand grass which can stand being covered up almost to the tip and shows the faculty of growing through the sand. Owing to its profuse horizontal additional roots, the above

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plant is able to avail itself of the sub-superficial moisture horizon which is found everywhere in the moving barkhans. "Seline" forms, large shrubs up to 1 m. high and 0.5 m. in diameter, arranged in groups, in the majority of cases are stretching parallel to the base of the barkhan rows which they usually surround.

The large stems, 5-8 mm. in diameter, are rather coarse, and the leaves are also somewhat coarse; nevertheless, this grass is almost the only forage found in the barkhans. It is used as pasture as well as for hay, the latter being stored in great quantities for the winter, when it is eaten by cattle and even by horses.

As regards the chemical analysis of Aristida, it rather closely approaches that of other seed grasses, as may be seen from the analysis (see table 5). Aristida covers not less than 10 per cent of the area occupied by barkhan sands.

In the hollows occur annual sand hallophytes Agriophyllum latifolium F and M, which are more palatable than Aristida, but stay much behind the latter in their mass. Sometimes the shrub Smirnovia turkestana Bge. is met with.

In the part of barkhan sands bordering on the Amu-Daria, sometimes Alhagi camelorum Fisch. is met with in the hollows. It is also met with amid the barkhan sands at the bottom of deep hollows with near underground water. Alhagi

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is stored for the winter in great quantities as hay for camels.

Sometimes in the barkhan range are met with long (up to several versts) narrow lowlands stretched, on the whole parallel to the Amu-Daria, with compact silty surface on which stagnate puddles of rain or snow water and where penetrate sometimes the waters of Amu-Daria or Balkh (near the Afghan frontier). Such valleys are covered with thickets of Phragmites communis Trin., the grass Aeluropus littoralis (Gouan) Parl., the shrubs Tamarix, Alhagi, etc., and represent comparatively rich and various pastures.

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Paragraph 2. GRAZING.

The diversity of the vegetation of the sandy-clayey plain secures pretty good pastures. Its chief value is represented by the herbaceous cover consisting of annual grasses and Carex physodes, and afterwards by Artemisia herbaceous Salsolaceae, Astragalus, Ammodendron squarrosus and the shrub Salsola Richteri. Photo 36 (p. 120) shows a flock of Astrakhan sheep on the Northern border of the sandy-clayey plain.

With regard to irrigation, the sandy-clayey plain is the only region of South Karakum which might be utilized to a considerable extent for the purposes of irrigated agriculture. This is due to its comparatively level surface and its soil which is either clayey or with clay underlying at an inconsiderable depth; moreover, the soil is little salty, especially in the Southern part.

The sandy-clayey plain singled out in the present work as a special natural region of South-Eastern Karakum, coincides with the North-Eastern half of the "sand steppe" marked out by Obruchev for the vast expanse of 10-12 thous-

and square versts, limited in the South by the hilly tracts of Afghan frontier, in the West by the river valley Murgab, in the North approximately by the line Yolatan-Burdalyk, and in the East by Kelifsky Uzboi.

Paragraph 3. SANDY RIDGES.

This type of sands is represented by high (up to 50 m.) long (3-5 klm.) sandy ridges consisting of fine reddish-yellow sand and stretching chiefly from North to South or from N. N. E. to S. S. W. The processes of growing over are so far advanced in these sands that their whole surface is richly covered with vegetation. Only on the summits of these ridges, near wells, bare sand due to secondary deflation may be met with. The larger areas of these sands (1/4-/2 of a square klm.) are covered with small moving barkhan rows.

The surface of the sands is entirely grown over; small bare areas may be found only on the highest summits. It is to their small area that the psammophytes Salsola Richteri Karel. and Aristida pennata Trin. variety minor Litw. are confined. The upper parts of the slopes, especially of the steep ones, are occupied by the shrubs Calligonum setosa Litw. Astragalus ammodendron confirmans

(Freyn.) N. Basil and sometimes Calligonum microcarpum Borszez, with a herbaceous cover of Carex physodes.

The lower parts of the slopes are almost deprived of shrubs, showing only dead, thinned brushwood. The sedge cover is poor and to a considerable degree replaced by the annual grasses Bromus tectorum L. (the chief element) and Agropyrum orientale L. (admixture).

The gently sloping foot of the ridges and the broad bottom of the valleys between them are devoid of shrubs. The cover of Carex physodes is met with only in form of scattered dying-out islets, usually confined to places of old deflation.

The whole surface is covered with a thick growth of the grasses Poa bulbosa L., Bromus tectorum L., and B. oxyodon Schr. Sometimes this excellent pasture is joined by the annual Astragalus filicaulis F. and M., with thin stem, which still increases the fodder value of these pastures. In the summer of 1926, this grass cover, owing to a very moist spring, was so well developed that it might have yielded a hay crop, especially in using a mower.

In order to ascertain the forage resources of the sandy ridges, a geobotanical investigation of the border area between the sandy ridges and the foot hills, embracing in the South-Eastern part the largest hill Tegelek-Kyr, has been carried out.

The associations with Bromus tectorum L., as chief element, or as considerable admixture, have been singled out with regard to the amount of forage. The thick growth of B. tectorum L. yields about 44 poods per hectare, the admixture of B. oxyodon Schr. increases this amount to the maximum figure - 60 poods, the admixture of Poa bulbosa L. produces about 50 poods and the admixture of Carex physodes M. B. - a wide-spread association of the slopes - about 40 poods; finally, Bromus tectorum L. as inconsiderable mixture to Poa bulbosa L. (the most wide-spread association covering the bottom of the ravines and the foot of the shelving slopes) - about 50 poods per hectare.

The smallest amount of forage is yielded by Carex physodes M. B. in pure condition (occupies small areas on the slightly denuded summits) about 19 poods per hectare, with the admixture of Bromus tectorum L. - about 24 poods.

The forage resources of the Southern part of the sandy ridges, adjoining the Murgab valley, may be determined as 36 poods per hectare, on an average.

A more detailed study of the vegetation cover of the sandy ridges shows, that in this part of Karakum, the processes of spontaneous growing over have reached a very high development. Especially during the last 8-10 years, since the time that all flocks of sheep were driven away from the

Karakum sands, these processes of growing over proceed at a high rate.

The grass cover at the bottom of the valleys and on the lower part of the slopes has greatly developed at the cost of the sedge cover. This has led to a much greater compactness of the sand at the surface, as well as to a considerable decrease of moisture, checking the further renewal of the sand shrubs.

Only the young specimens of Astragalus ammodendron confirmans (Freyn.) N. Basil are met with, and even these are of rare occurrence. The other shrubs, Calligonum setosum Litw., Calligonum microcarpum Borszez, to say nothing of Salsola Richteri Karel., are found on the lower part of the slopes, either as dead brushwood or showing a very poor growth. In the middle part of the shelving slope these shrubs are still alive, but already growing old.

Only along the borders of the grooves wrought by secondary deflation, where half of the roots are spreading under the denuded sand surface, the condition of the shrubs is near to the norm. Only on the bare summits, and near them, occur shrubs in young, fresh condition, showing sufficiently intensive growth and tall habit. Self-dissemination and offshoots of the sand shrubs are equally confined

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to the bare summits, sometimes to the grooves of deflation. In all places showing a grass cover, self-dissemination is entirely missing.

Further development of the processes of growing over, without the agency of man with his flocks, must lead these sands, during the next five years to the final stage of development; and in regions where the saxaul does not grow, this final stage finds its expression in a special "steppe" of annual grasses, Poa bulbosa L. and Carex desertorum Litw. Under these conditions the sand shrubs, as well as the cover of the sand sedge die out completely.

The above-mentioned grass cover serves as an excellent pasture and may even yield a hay crop, but exclusively in years with abundant rainfall, when it reaches a fair development. In years of medium rainfall, the pasture is scanty and in dry years the grass cover almost vanishes.

On the contrary, Carex physodes M. B., with its attendants, growing on sand which has still preserved a certain looseness and therefore presents favorable water conditions, develops satisfactorily even in the driest years. The sand sedge is thus the most reliable forage which one may be sure to find every year.

Therefore, the rapidly developing growing over of the sandy ridges, observed during the last ten years in the part of the region adjoining the Murgah valley, must be regarded as

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a process impairing the economical value of this immense part of Karakum. With further unchecked development of the processes of growing over, this part of Karakum will be a good pasture only in exclusively favorable years; all the other time, it will not be able to keep its flocks in food.

Still sooner, the further development of the processes of growing over will make the above-mentioned part of Karakum lose its importance as the source of fuel for the population. After 5-10 years the remaining shrubs will have died out almost everywhere, leaving small groups only on the summits of the ridges and along the grooves wrought by deflation. With regard to these grooves, it must be said that under the influence of unchecked growing over, they markedly decrease their area, becoming covered with vegetation.

In order to maintain the great importance of the sand ridges adjoining the Murgah valley, as pastures and as a source of fuel, it is necessary to re-establish sheep-breeding in this region. The flocks of sheep eating in the first place the grasses and loosening the surface layer made compact by these grasses, may induce a condition of the sand favoring once more the development of Carex physodes with its attendants - the most reliable form of pasture. The cover of sedges WILL SECURE THE RENEWAL of the sand shrubs and thus restore to the Karakum sand ridges their importance as a source of fuel.

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Thus, with regard to the sand ridges adjoining the Murgab valley, measures must be recommended which may easily seem paradoxical. These are not measures of controlling the development of the sands, but measures promoting a certain regressive development of the sands having attained an extreme degree of growing over.

Paragraph 4. GRAZING ON THE NORTHERN BORDER OF THE FOOTHILLS OF THE HINDU-KUSH.

The sandy ridges are limited in the South by the Northern border of the foothills which adjoin the Southern part of Karakum, near the Afghan frontier. These foothills show in their Western part a height which by 3-4 times exceeds that of the sandy ridges, and are separated from the latter by valleys, or lowlands, not deep but broad, stretching in latitudinal direction and showing rather compact soils with a thick grass cover.

The Northern hills, as for instance Tegelek-Kyr and the neighboring ones, consist of thick layers of very fine sand whose surface has been so much changed by processes of growing over and soil formation that it is covered with a fine grayish sandy soil, rather compact in places. These soils show a grass cover of *Carex desertorum* Litw., which is char-

acteristic of the foothills and does not occur on the sands. Carex physodes M. B. is as a rule missing.

In the upper third of the slopes, on compacter soils, occurs the most xerophytous grass, Stipa subbarbata Keller, which forms here inconsiderable thin stands.

An excellent proof that the hills under the thin soil layer consist of loose sand, or more exactly are covered with it to a considerable depth, is the occurrence of grooves wrought by deflation on the summits, and less frequently on the slopes. These grooves, eight or more meters deep, show on their vertical walls the thickness of the sorted aeolian sand. In connection with this, the vegetation of the deflation grooves and of the recently accumulated sand mounds surrounding them and showing rather bare surface, is a typical sand vegetation.

The importance as forage of the herbaceous cover, consisting of Carex desertorum Litw. is not great. The small areas of Stipa subbarbata Keller are to little avail in improving it, while the sand vegetation confined to the deflation grooves occupies but an insignificant area. Only the valley-like depressions between the hills, occupying large expanses, represent fair pastures with their cover of grasses which, owing to greater moisture, is here sufficiently reliable.

Thus the sand desert South-Eastern Karakum shows sufficiently abundant forage resources to allow of sheep breeding

on a scale twice as large as that before the revolution which was already large enough.

A corresponding increase of the number of wells and "kaks" for watering is equally quite possible.

Paragraph 5. SANDS BORDERING ON THE AMO-DARIA VALLEY, THEIR NEGATIVE ECONOMICAL IMPORTANCE AND THE PRINCIPAL MEANS OF CONTROLLING THEM.

The population of the left bank of the Amu-Daria, living on a narrow (2-4 klm.) strip of cultivated land, has to deal throughout the whole length (250 klm.) of this strip, with the adjacent sands.

These sands threatening the kishlaks and burying every year farms, aryks, gardens, and fields are however, not only of negative consequence for the population, but their positive importance is equally very great. They serve as pastures, as sources of hay and fuel, and finally represent the only available lands with which to increase the cultivated acreage. With the dense population of the Amu-Daria oasis and the intensive agriculture carried on there, the need of land makes itself felt.

In a short time these measures will lead to excellent results. If the cutting down of _Alhagi camelorum_ near the

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kishlaks is abated, and the plants are preserved during 1-2 years, the dead plants which decay very slowly and are very spiny, will form a thick cover on the small and middle-sized hillocks of the transitional zone and make them inaccessable to animals (even horses are with difficulty persuaded to step on old Alhagi). Thus the old shrubs of Alhagi will do away with pasturing and the loosening of the soil connected with it, and the protection of the sand will be practically realized.

After 3-4 years, the sand under the thick growth of the camel thorn will have become sufficiently compact to admit pasturing. For this purpose the old brushwood may be burned in spring before the appearance of the young shoots (the camel thorn begins to develop in spring much later than other plants). As the burning of the herbaceous cover practised every year on the sand hills of district Kushk has shown, the young growth of Alhagi will develop the better for it.

The burning of the dead brushwood may be carried out when the summer winds set in, driving away the sands from the kishlak zone, and the denuded area presents no danger. Moderate pasturing during the summer does not destroy the camel thorn with its string growth, and in fall it sufficiently covers the soil, to protect it against the winter winds driving the sands towards the kishlaks. Thus, in

abating the cutting down of *Alhagi* and burning each spring the dead shrubs, the camel thorn may be used as pasture for camels and sheep, without increasing the danger presented by the sands.

Paragraph 6. "The Meadow Tracts of the Desert Transuralia".

iblio: 2 The region of the lower courses of the rivers Emba, Uil, Dzhaksy-bai, Koldygaity, and others, investigated by the authors, is situated between $46^{\circ}40'$ and 50° North Latitude and $52^{\circ} - 54^{\circ}30'$ West Longitude, from Greenwich.

Geomorphically the investigated region represents a plain, characterized in its Southern part by negative heights (down to 26 m), and covered by young, strongly salinised deposits of the Caspian transgression. Beyond the coastal solonchak belt, 8-12 km. wide, subject along its borders to saline maratime floods, the landscape of the plain is characterized by numerous systems of closed, flat depressions, called "shor" entirely covered by saline mud and deposits of self-precipitated salts.

Northward in the region drained by river-valleys, the number of "shors" diminishes, the relief becomes more intersected, presenting a succession of gently sloping hillocks

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and depressions with smooth takyr surfaces and solon-chaks. At the border of the Sub-Ural plateau, in the North, the surface of the plain is strongly dissected by erosion, and outcrops of Tertiary and Cretaceous rocks are encountered.

The chief water arteries of the described region, the rivers Emba, Saghiz, Uil and others, start within the limits of the Sub-Ural Cretaceous plateau, where they have well-formed valleys with three terraces and a great number of tributaries.

On entering the Caspian plain, the river valleys become much less marked and are deprived of tributaries. Approaching the flat depressions, the rivers disappear in them and again reappear at the other end of the depression. This phenomenon may be accounted for by the youth of the relief and of the erosional cycles of the Caspian plain. One of the characteristic peculiarities of the rivers in the Caspian plain is their isolation from their natural erosion basis - the sea, as the rivers disappear in the closed declivities of the "shors" and lakes.

We can distinguish three different kinds of valleys, those of a lower, middle and higher level, differing by the intensity of flooding. As to the amount of precipita-

tion and the temperature of the vegetative period, the Caspian plain is very much like the neighboring desert regions of Middle Asia, 161 mm. in the Southern and 193-250 mm. in the Northern part of the region.

Hence the summer-autumn period (May-October) is distinguished by a gradual diminishing of moisture, depending on the aridness of the climate, an almost total absence of precipitation and a maximum development of evaporation.

According to the soil-botanical investigation of the Caspian plain river valleys, three chief factors may be distinguished to which the heteirogeneity of vegetation and soil varieties is due, and these are the water regime of the river valleys, microrelief of the latter, and the salinity of the ground.

Alluvial sediments - the parent material of meadow soils - are directly connected with the underlying salt bearing deposits of the Caspian transgression (overflow of the surrounding land). The influence of the subsoil, which salinises the soils, and of the ground water, usually lying in the sphere of the development of intense capillary processes during the hot periods of the year depends largely on the microrelief of the meadows and is tempered by the dissolving action of the spring flood fresh waters.

The difference in duration of surface flooding, as well as the conditions of the run-off, frequently determine the main soil varieties of the Caspian plain river valleys.

Meadows of excessive moistening may be subdivided into two types of habitat: depressions of basins without outlet with stagnant water, during all the vegetative period, and low swamped meadows with water drying at the end of the summer. The first type is characterized by thickets of the following:

PHRAGMITES COMMUNIS TRIN.
SCIRPUS LACUSTRIS L.
" TABERNAEMONTANI GMEL.
TYPHA ANGUSTIFOLIA L.
" LATIFOLIA L.

This vegetation having a considerable production, possesses but low forage qualities. Thus Phragmites communis Trin. attains the height of 2 - 4 m. and has a provision of dry mass 100 - 150 cwt. to a hectare. Nevertheless, only a part of this mass may be used for forage and only in the form of silos. The second type of habitat is characterized by the groupings of Scirpus maritimus L. and the following:

HELEOCHARIS CRASSA. FISCH.
" UNIGLUMIS SCHULT.
" PALUSTRIS R. Br. s. ampl.

BUTOMUS UMBELLATUS L.

Meadows with SCIRPUS MARITIMUS L. yield hay of but poor forage qualities. Nevertheless, the population stores this plant for hay, for want of other forage. The prevailing soils of these meadows are swamped salinous solonchaks and alkaline solonchakous-solonetsous soils.

The moist swamped meadows are predominantly grown with species of the genus Heleocharis and Beckmannia cruciforms Host. The first plant has a provision of mass 16--32 cwt. to the hectare and often is not mown at all, due to its low forage qualities. Meadows with Beckmannia cruciformis Host., generally have an admixture of Agropyrum repens P. B., which augments their forage value. The dry mass provision of such meadows is 40--65 cwt. to the hectare. Meadows of a moderate moisture are characterized by the existence of runoff of spring flood-waters into the lower lying tracts; therefore, the process of solonetsous soil formation is here developed.

According to the conditions of the habitat, these meadows are also subdivided into two types: of optional (permanent) and of irregular irrigation. The first type is characterized by groupings of Agropyrum repens P. B., of 1 m. middle height and a provision of dry mass 49--65 cwt. to the hectare. These meadows yield the most valuable forage hay crops. The different varieties of solonetsous soils of these meadows are less swamped.

The second group of meadows of moderate moistening occupies more elevated elements of the relief and is not uniformly irrigated. These meadows are mostly covered with various herbaceous growth, however, with a predominance of Agropyrum repens P. B.; and here exist also solodised soil varieties. On higher tracts of these meadows and along their border are often found more salinised soils with a predominance of the groupings of the following:

WELUROPUS LITTORALIS PARL.
JUNCUS GERARDI LOIS
CAREX STENOPHYLLA WAHLENB.
ATROPIS DISTANS GRIS
" CONVOLUTA GRIS
ARTEMISIA MARITIMA L.
variety SALINA KELLER
STATICE GMELINI WILD

The provision of the dry mass of these meadows is 25--36 cwt. to the hectare.

The prevailing groupings of vegetation on meadows with an insufficient moistening, flooded only in the years of high water, are as follows:

ARTEMISIA MARITIMA L.
AGROPYRUM CRISTATUM P. B.

AELUROPUS LITTORALIS PARL.

STATICE GMELINI WILD the species of the genus SALSOLA, etc.

On meadows of more Northern districts the prevailing groupings are as follows:

ARTEMISIA MARITIMA L.

AGROPYRUM CRISTATUM P. B.

on alluvial solonetsous and slightly solonetsous soils with ground waters, usually lower than two meters.

On meadows of Southern districts prevail groupings of

AELUROPUS LITTORALIS PARL.

This grass yields about ten cwt. to the hectare, but thanks to its shoots spreading on the earth surface, its hay crop is really much lower.

AELUROPUS LITTORALIS PARL.

should be considered for culture purposes, as owing to its high halophyteous qualities, it can live even on puffed solonchaks. On unflooded meadows with prevailing solonchaks, in connection with intensely developed processes of salt accumulation in conditions of the Caspian plain salinised subsoils, generally a halophyteous shrub prevails, namely,

HALOCNEMUM STROBILACEUM M. B.

Extensive areas, thousands of hectares of puffed solonchaks with HALOCNEMUM STROBILACEUM M. B. surround meadow tracts in the lower course of the rivers Emba, Uil and Dzhaksvbai.

Thus the vegetation of the investigated meadows in the Caspian plain possesses very low forage qualities; but can, nevertheless, be transformed, when applying very simple methods of amelioration, into highly productive, excellent hay crops.

The reclamation of the meadow regions of Western Kazakstan is the foundation necessary for the socialistic reconstruction of the local extensive pasture cattle-breeding semi-nomad economy.[1]

To such meliorative measures belongs the problem of water supply in the region, and "liman" irrigation. By the expression "water supply" we mean chiefly the measures for the creation of drinking ponds in order to use more productively the immense provision of natural forage in the inter-river region. The utmost poverty of the Caspian plain in water springs is augmented by a considerable salinisation of the surface waters, as well as of the ground waters.

Therefore the means of retaining the fresh water of spring floods, acquire a great importance. The most rational and cheapest way of liman irrigation, accessible to the local population, provided there be some technical indications, consists in the building of earthen dams across the

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1. In a close connection with questions of the appropriation of this region to the development of a highly productive cattle-breeding (meat and wool) economy, stands its industrial development in connection with the Emba mineral oil industry.

stream bed. The flood-waters are distributed among the meadows by means of ditches and directing banks.

According to our observations, the intensity of the seasonal variations of the salt-regime in meadow soils requires a sufficient washing, during the flooding, for otherwise the meadow vegetation will die out, giving way to salt loving plants.

In the irrigation of meadows by the spring-flood waters, the duration of the flooding is of the greatest importance. An insufficient flooding has a small effect on the removing of the salts and on the general moistening of the soil; whereas, a flooding of too long duration leads to the development of swamping processes, and a secondary salinisation of the soil. Therefore, the flooding must not exceed 8--15 days and should be accompanied by the drainage of meadows. According to observations, instead of the poor crops with

SCIRPUS MARITIMUS L.

highly qualified hay crops with

AGROPYRUM REPENS P. B.

may be obtained on meadows of excessive moistening through draining alone. Such meadows may be created likewise on tracts with an insufficient moistening. In conditions of strongly salinised meadows it is possible to obtain the growth of such salt withstanding grasses as the following:

ATROPIS CONVOLUTA GRISB.

ELYMUS ARELENSIS RGL.

AELUROPUS LITTORALIS PARL.

AGROPYRUM CRISTATUM P. B.

Finally attention should be drawn to the wild-growing forage plants, such as the following:

MEDICAGO COERULEA

" FALCATA L.

LOTUS CORNICULATUS L.

MELILOTUS DENTATUS PERS.

" POLONICUS

" ALBUS DESR.

LEPTURUS PANONNICUS KUNTH.

FESTUCA ARUNDINACEA SCHREB.

species of the genus

CRYPSIS

CYNODON DACTYLON PERS. etc.

The above-mentioned plants withstand well a considerably salinised soil. The vegetation of sands widely spread in the Caspian plain has also considerable forage funds. Here attention should be drawn to the following plants:

AGROPYRUM SIBIRICUM P. B.

CALAMAGROSTIS EPIFEIOS ROTH

" PSEUDOPHRAGMITES KOLL.

FESTUCA BECKERI HACK

GLYCYRRHIZA GLABRA L.

ELYMUS GIGANTEUS VHAL. etc.

in conditions of sands with shallow ground waters, the culture of Medicago sativa is possible.

The complete solution of the problem of reclamation of the salinised soils of the Caspian plain requires the establishment of stationary experimental investigations for purposes of studying the means of physical and chemical melioration of solonchaks, the water regime of the soils in connection with the question of secondary salinisation, the possibilities of retaining the fresh water of spring flood, the means of liman agriculture, of cultivating local species of salt withstanding forage plants and of introducing forage plants from other regions.

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Paragraph 7. (1). "THE BALKHASH REGION (GRAZING)".

(2). "WESTERN BALKHASH SANDS".

Biblio: i and 2

The investigated area of the sands of the Balkhash region, situated in the former Semirechie province in Kazakstan, extends Northward as far as the lake Balkhash, and in the South it reaches the foothills of the Djungarian Alatau, thus lying between the 44^{o} and the 45^{o} 20" North Longitude, and 74^{o} and 78^{o} East Longitude from Greenwich.

Climatically this region belongs to the moderately hot zone of the Balkhan district, which is distinguished by high mean temperatures in summer, the mean temperature of the vegetation period being 20 - 24^{o} ; the annual rainfall amounts to 150 mm. in the Northern, more arid part of the region and 250 mm. in the Southern part near the mountains. In its natural condition the region represents a desert almost uncultivated in its territory, occupied by an immense sandy tract extending to about seven million hectares, and by the ancient, totally waterless valley of the river Ili.

The predominant occupation of the population is extensive pasture-cattle-breeding with the addition in places of agriculture; however, the region of the Balkhash lake acquires now, in connection with the general rate of socialistic reconstruction of the economics of our country, a first rate importance.

The considerable stretches of the Balkhash lowland within the limits of the investigated region may be subdivided into the following landscape units; the areas of hillocky, crest-hillocky, and level sands, in the Eastern part of the region, the ancient delta of the Ili river, the Balkhash lake with its Southern shore and the modern valleys of the rivers Ili and Karatal.

The Balkhash lowland is a closed basin, filled with Post-Tertiary fluvio-glacial alluvial-lake deposits, its erosion basin corresponding to the level of the Balkhash lake. The surface of this lake amounts to about 17.5 thousands square km.; its length is about 595 km., and its width varies from 75 to 7.5 km.; its depth varies as considerably, from 25 m. to 1.5 m. The water in the lake is fresh, or slightly salty. The salinity of the water is considerably higher in bays and coastal lakes. According to investigations, the level of the water in the lake is subject to periodical variations. Up to 1910, the water level in the lake was rising and in the next

period of years it was in the state of lowering as much as for 2 - 4 m. This is evident from the following facts: areas of dried rush along the Southern shore, joining of former islands to the mainland, retreat of the lake near the settlement of Kuigan.

The shore line (shown on the map as the I region), several kilometers wide, is in peculiar conditions of water regime on account of the periodically changing surface and ground water regime. The Eastern part of the shore-line between Chit-Bakanas, the dry ancient bed of the river Ili and the river Karatal are bordered by hillocky sands, which in places approach the lake. In the declivities between the sandy hillocks are met with puffed salonchaks (saline), with a scarce vegetation of Salsola, and lakes on whose water surface may be observed the formation of salt-crusts. From larger lakes the inhabitants extract salt. The Western part of the shoreline, within the limits of the ancient delta of the Ili river is characterized by a more even relief, only partly varied by sandy hillocks. The prevailing vegetation of the coast is wormwood (Artemisia terrae albae H. Krasch), and different species of Salsola.

In the bay and lakes along the coast, narrow strips of Phragmites communis Trin. are found.

In the deposits of such strips, not infrequently, thin

layers of rust-peat may be observed. On the sandy ground the usual psammophitic vegetation is developed.

The most important water course of the Balkhash region is the Ili river, which by its water debit (465 square m. second) occupies the third place in Central Asia, following in that respect the Amu-Daria and Syr-Daria rivers.

The region of the lower part of the modern Ili valley (mapped as region VI), is subdivided into three subregions: the upper, the middle and the river-delta. From the station Iliisk of the Turkestan-Siberian railway line, down to the latitude of the locality of Maraldy, the river flows in a narrow gorge, crossing the foothills of the Djungarian Alatau. On entering the Balkhash plain, the Ili river forms a wide valley, with three well-formed terraces. The first terrace was usually a small width, 1-2 km.

The soils of the terraces are loamy and loamy-fine sand deposits, underlain by gray micaceous sands, sometimes with gravel and pebbles.

Characteristic of the landscape of the first terrace are meadows, tree growth and shrubs. Eleagnus angustifolia L. species of the genus Salix, Berberis integerrima Bge. species of the genus Rosa and others.

The second terrace frequently extends to several kilo-

meters of width. Here are usually situated the agricultural irrigated plots. In the natural conditions here, thickets of Halimodendron argenteum D. C., and meadows prevail.

The third terrace is up to 4-6 km. wide and is characterized by the general prevalence of Artemisia - Salsola associations, thickets of Stipa splendes Trin, and in places thickets of Tamarix and Arthropytum Haloxylon Litw., Nitraria Shoberi L.

In the delta region, the main river bed divides into a series of streams which alternate with lakes, swampy patches and solonchaks. In the delta, predominate thickets of Phragmites communis Trin. The valley of the Ili river is bordered by a sandy tract. The smaller valley of the Karatal river, is characterized by landscapes very like those described for the Ili river valley.

The prevailing soils are light takyr serozems and immature silty-sandy soils with a scarce Artemisia-Salsola covering and thickets of the solonchak saksaul (Arthrophytum haloxylon). About half of the area of this plain is occupied by separate groups of sandy crests and more or less even sandy tracts with a psammophitic vegetation. The sandy crest is 4-6 m. and in places up to 10-14 m. high.

Along the beds, crossing the ancient delta, is frequently

observed a dying-out hydrophile vegetation, as follows:

POPULUS DIVERSIFOLIA SCHRENK

HALIMODENDRON ARGENTEUM D. C.

TAMARIX

In places, traces of former agriculture are met with, consisting of a system of irrigation and ruined buildings. The vegetation of the hillocky-crest sands on the top of the crests with loose sand, is usually represented by psammophitic shrubs; species of the genus Calligonum, sandy saksaul (Arthrophytum arborescens Litw.).

Ammodendron argenteum D. C., and a scarce cover of herbaceous psammophitic. The slopes of the crest with a more or less expressed soil formation process of loose sandy serozems are covered with a thicker vegetation, consisting of the following:

EUROTIA CERATOIDES C.A.M.

ARTEMISIA SONGORICA SCHRENK

CARES PHYSODES M.B.

KOCHIA PROSTRATA FENZL.

variety VILOSISSIMA etc.

On the intercrest tracts are usually observed sandy-silty serozems with a well developed fine loamy-sandy upper horizon. Here generally predominate groupings of the following:

EPHEDRA LOMATOLEPIS SCHRENK

ARTEMISIA TERRAE ALBAE H.

KRASCH

CAREX PHYSODES M.B.

with numerous annual plants.

In the middle part of the sand, thickets of Arthrophytum Haloxylon Litw. are very common. The undulating, hilly areas of the sandy steppes (Southern region) prevailingly bear the following vegetation:

ARTEMISIA TERRAE ALBAE H. KRASCH

KOCHIA PROSTRATA FENZL. VAR.VILLOSISSIMA

AGROPYRUM SIBIRICUM P.B.

In places the following are met with:

STIPA SZOWITSIANA TRIN.

" CAPILLATA L.

POA BULBOSA L.

and numerous annual plants. The soils are compact fine sandy-loamy and sandy serozems.

Along the borders of sandy tracts, especially on the boundary of river valleys, frequently occur secondary types of sands deflated in connection with human activity. Such are the barkhan and the small hillocky sands.

On these also frequently occurs the caoutchouc-bearing plant Chondrilla ambigua Fisch. var. crassicola Iljin.

As to their origin, the Balkhash plain sands are delta-lake deposits of the vast ancient Balkhash water basin deflated in the preceding xerothermic periods of the Interglacial epoch. In the Northern foothill part, these sands are underlaid by proluvial fluvio-glacial deposits.

The Ili and Karatal river valleys and the Bakanas plain may be used for purposes of intensive agricultural farming; however, on condition of irrigating these areas.

The sands of the regions have considerable provisions of pasture forage and may be used for cattle-breeding, for which purpose it is necessary to organize grass-sowing on sands, in order to furnish forage for the winter period.

The Balkhash plain acquires a first-rate importance for the supplying of the Balkhash copper-melting combinate.

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PARAGRAPH 8. "The Sands of the Urda Region - Western Kazakstan".

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The present paper treats of the sands and sandy steppes of the semi-desert Urda region of Western Kazakstan, whose geographical position is determined by the co-ordinates 46° 30' North Latitude.

The sands and the sandy steppes (ashiks) of the region, occupying about 1 mil. hectare, i. e. 30 p. c. of the total area, are by their natural conditions - highly valuable and may be turned, provided a proper organization, into a granary for the whole region. The presence of collective and state-farms, of machine-hay-making stations, etc., combined with exceptionally favorable natural conditions, forms a solid basis for the development of cattle-breeding in this region (cattle, sheep, horses, camels, goats) and consequently for its general economic growth.

The climate of the region is thoroughly continental. The summer is characterized by high temperatures of the air as well as of the soil surface, with frequent S. E. and E. winds up to 12.5 m/sec. The winter is cold with snow storms, the depths of the snow cover being up to 20-30 cm. Precipitation is not regularly distributed and bears a character of

showers attaining 720 mm. a year. The influence of strong insolation, high evaporation and of the dryness of the air (relative moisture), falling down to 11 p. c. on the formation of the vegetative cover cannot be denied. Nevertheless, the favorable water regime (with a depth of ground waters to 1-3 m.) of the hillocky sands, creates adequate conditions for shrub and tree growth and for a varied and luxurious herbaceous vegetation of the ashiks.

The region is level, gently sloping towards the Caspian Sea and lowering in the area of the described sands down to negative heights. The region is neither dissected nor worked, but the surface of the steppe, which seems generally level, is slightly varied by the presence in the North-Eastern and Eastern parts of the region of sandy hills, which mostly have the form of sinuous ribbons stretching from North-East to South-West. On the whole, the region is devoid of permanent water sources; there is but one small river, whose water is fresh for a short time in spring and in summer it becomes salty and is partly dried.

The ground waters which occur at a depth of from 6 to 13 m., play an important role in the water-regime of the region.

In the sandy tracts, as well as under ashiks ground waters are encountered at the depth of 1-6.5 m., and rarely as deep as 10 m.

The richest in fresh ground-waters are the hillocky sands, where in depressions water even frequently appears on the surface. Therefore, the sands and ashiks should be considered as areas having a high economical value in the economy of the given semi-desert region. In the seventies of the last century, this sandy area, 160 km. long and 25-45 km. wide, was considered as the best land for the nomad kalmyks, because of the presence of water, fodder and of shelter from winter snow-storms for cattle. The present kosak population also uses the sands and ashiks as pastures and haymaking areas.

The hillocky sands are covered with the following tree and shrub growth:

POPULUS ALBA
" NIGRA
" TREMULA
" HYBRIDA
ALNUS GLUTINOSA
ELEAGNUS ANGUSTIFOLIA
ROSA CINNAMOMEA
" CANINA
SALIX CASPICA
" ROSMARINIFOLIA
RHAMNNS CATHARTICA

<u>CALLIGONUM PALLASII</u>

<u>TAMARIX "</u>

<u>PIRUS MALUS L. G. N.</u>

Wysotsky also mentions the following:

<u>POPULUS BACHOFENI</u>

<u>PRUNUS SPINOSA</u>

The shrubs and herbaceous vegetation consists of the following:

<u>ARTEMISIA ARENARIA</u>

<u>ARISTIDA PENNATA</u>

<u>CENTAUREA SCABIOSA</u>

<u>ELYMUS GIGANTEUS</u>

<u>AGRIOPHYLLUM ARENARIUM</u>

<u>CHONDRILLA AMBIGUA</u>

<u>CORISPERMUM INTERMEDIUM</u>

<u>LINARIA ODORA</u>

<u>CAREX LIGERICA</u>

<u>FESTUCA BECKERI</u>

<u>CALAMAGROSTIS EPIGEIOS</u>

<u>POA TATARICA</u>

<u>MELILOTUS CASPICUS</u>

<u>CAREX STENOPHYLLA</u>

<u>PHRAGMITES COMMUNIS</u> etc.

The hillocky sands destroyed through the activity of man are chiefly grown with Elymus giganteus and Agriophyllum arenarium.

The ashiks - sandy steppes - are also disposed in the form of ribbons parallelling the hillocky sands and occupying an area of about 10,000 hect. Their relief is more or less level, but with a marked slope in the direction from the borders towards the center.

The ground waters lie at the depth of 1 to 3 m., but they are considerably more salty and contain more mineral matter than the ground waters of the hillocky sands. Nevertheless, they are quite fit for consumption. The soil profile on the ashiks is clearly expressed. The thickness of the humus horizon increases, the coloring changes according to horizons, in the mechanical composition clay and smaller fractions of sand predominate, and the effervescence level rises. The Caspian clay with characteristic mollusks, lies 1 to 2.5 m. deep.

A total absence of treegrowth is characteristic of the ashiks. However, in the vegetation of various composition according to relief, soil edaphic and water conditions, may be distinguished a series of types, as follows:

1. Predominance of Artemisia, admixture of Centaurea scabiosa and Euphorbia Gerardiana.

2. Predominance of Festuca Beckeri and Stipa Joannis.
3. Predominance of Artemisia campestris, Festuca Beckeri, Stipa Joannis, and Agropyrum sibiricum.
4. Predominance of Artemisia scoparia and Agropyrum sibiricum.
5. Prevalence of Poa tatarica, Agropyrum sibiricum and Artemisia salina.
6. Prevalence of Atropis distans, Agropyrum sibiricum and Artemisia salina.
7. Prevalence of Suaeda maritima, Suaeda corniculata, Salicornia, Artiplex, Francenia, etc.

All these types having a different herbaceous stand give a different production, and therefore, every type has its own economical value.

It is evident from literature, that formerly the hillocky sands were overgrown with different kinds of trees and bushes. The transmigrations of kosaks from beyond the Ural, with numerous herds of cattle (taking into consideration the nomadic extensive pasture system, which existed before the October revolution), could not help but bring about the destruction of the vegetative cover, the disturbance and blowing away of the sands and sandy soils.

This was especially noticeable in the vicinity of the residence of the Khan (at present the village Urda), which had repeatedly been buried under sands. This fact and the exhaustion of the pasture lands induced the creation in 1888, of a special forestry for the administration of the forests and the regulation of the pastures.

As a result of the activity of this institution, the herbaceous growth on the pastures and hay fields was considerably improved, the area occupied by trees and bushes increased, and the blowing away of the sand was stopped.

Later on, over 40 kinds of trees and bushes had been as an experiment, sown and planted on the sands; likewise, Elymus giganteus and Agriophyllum arenarium were sown on the sands.

Much work has been accomplished by the Bukeev sand experimental station, organized in 1926. The work was concentrated on the second type of sand-formations, i. e., on Ashiks; experiments were made on the sowing of different forage plants, on different technical means of culture, and on the adequateness of sand plants for food.

The sowing of Elymus giganteus on billocky sands has resulted in a yield of 48 to 60 c. to the hectare.

The same plant on undisturbed ashik - as well as Agriophyllum arenarium have not given any positive results.

On the third type of ashik the best yield was attained with Agropyrum sibiricum and Medicago.

The experiments have proved that autumn is the most convenient time for sowing (presence of moisture, no deflation, or breaking of young plants).

The plowing must not be less than 15 cm. and not more than 20 cm. deep. The depth of the upper layer over the seeds must not surpass 2 to 4 cm.

The growing of annual forage plants has given no positive results. Of the perennial plants the best yields belong to the lucerne ashik and Glycyrrhiza glabra. Of all the gramineae Agropyrum sibiricum has given a good result almost in all ecological conditions of the ashik. This perennial plant is very nutritive and all kinds of cattle eat it; a good yield was obtained with Pennisetum Richard and sorgo, and a rather low one with Andropogon sudanense and the mais.

Further are cited data of the experiments on the digestibility of some kinds of sandy plants for camels; of their nutritive qualities, etc.

There is a detailed account on the results of the experiments on culture of vegetables and such plants as melons, water-melons and pumpkins; whereas, in conditions of watering with vegetables, the following are included:

CABBAGE
TOMATOES
CUCUMBERS
ONIONS
CARROTS
POTATOES
DILL
SESAMUM
TOBACCO etc.

Twenty-six kinds of bushes and trees were encountered on the hillocky sands, introduced by sowing or planting. The chief of them are the following:

PINUS SILVESTRIS
ROBINIA PSEUDOACACIA
CARAGANA ARBORESCENS
QUERCUS SESSILIFLORA
POPULUS ALBA
" HYBRIDA
" PIRAMYDALIS
MORUS ALBA
VITIS VINIFERA
AMORPHA FRUITICOSA etc.

The influence of tree culture on the soil-forming process on sands as manifested by the accumulating of fine particles,

the enrichment in humus (of a forest character) and by the increase of the contents of hygroscopic water in upper horizons.

In the concluding chapter is given an analysis of the conditions of nomad cattle-breeding economy since the transmigrations of kosaks, in connection with the utilization of the productive possibilities of the investigated sands: viz, deficiency of land, excessively high charges claimed by the Khan and his attendants, which led to reiterated revolts of the kosaks' cattle-breeders. The growth of population, the unreasonable management of pastures, the absence of elementary zoo-technical rules in reference to the breeding of the young, frequent epizootics, have often led almost all the cattle to destruction.

The Revolution created unexpected perspectives for the development of cattle-breeding in this region. The numerous and collective state-farms, the application of the latest achievements of science and technics in the Soviet Union, together with favorable natural conditions, contributed to the rising of the farming to an unprecedented height. Herewith arise problems of a more complete and wide application of the productive resources of the region, based on scientific exploration and on investigations of the latter.

The possibilities of a broad exploration of the hillocky sands in respect to forage are limited, owing to their natural properties.

The principal method of utilizing their vegetative resources, consists of the following:

1. In regularising their grazing and the private hay-making.
2. In the culture of Elymus giganteus with the purpose of obtaining seeds for concentrated forage; in the culture of Agriophyllum arenarium - for feeding.
3. In the culture of forest growth and fruit trees, in the development of viticulture, culture of technical plants, etc.

The ashiks, owing to their natural qualities, seem adequate to the solution of the principal forage problem. Ashiks which usually bring no low yields, even in the years of drought, provided suitable agricultural methods are used, may become a granary for the whole region.

The first attempts in this direction have been made by the Bukeev Sand Experimental Station, and it has been proven that the forage production on ashiks may be elevated to a considerable height in conditions of corresponding high qualities of the forage mass.

It is evident that many very valuable plants, such as Mais, sorgo, Helianthus L., Phaseolus L., Panicum L., and other agricultural plants down to the drought-proof kinds of rye and wheat, may find a place in the complex of procedures undertaken from the utilization of the sandy steppes.

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By: T. F. Yakubov.

CONCLUSIONS OF THE LAST TWO CHAPTERS

(HERBS, SHRUBS, VEGETATION IN TURKESTAN)

(GRAZING IN TURKESTAN)

The above-published results of the expeditionary investigations of the author and of the stationary observations and investigations of the Repetek Sand Station, enable us to divide the vast expanse occupied by South-Eastern Karakum, which reaches 57 - 57-1/2 thousand, of square klm., into five natural regions, as follows:

1. The Barkhan range adjoining the Amu-Daria, occupying an area of about 8-1/2 to 9 thousand square klm.
2. The sandy hills, with shrubs-psammophytes and saxaul forests about 9 thousand square klm.
3. The sandy-clayey plain - about 10 thousand square klm.
4. Sandy ridges about 14-1/2 - 15 thousand square klm.
5. The foothills of Hindu-Kush - about 14-1/2 thousand square klm.

Thus, on the expanse of South-Eastern Karakum, which constitutes but the sixth part (approximately) of the whole Trans-

Caspian Karakum, indicated on the maps by the uniform conventional color of sands, we find five natural regions, differing from each other by their properties, as well as by the rate at which these properties change. The barkhan sands which are in an early stage of development, evolve at a rapid rate, especially when they are passing over into the state of sandhills.

On the other hand, sands of the same type, but with saxaul forests, or the sandy-clayey plain, having reached the final stage of their development, remain almost unchanged during hundreds of years.

The difference in the economical value of these regions is equally great, beginning with the barkhan sands, whose vegetation occupies but a small percentage of the surface, up to the sandy hills covered with shrubs and the sandy ridges which represent excellent pastures for the Astrakhan sheep; or the sands under saxaul forests, which are the only source of fuel for the local population.

This considerable difference in the properties of the above-described regions, leads to the necessity of elaborating methods of phytomelioration which differ from one another not only in their technics, but also in their purposes.

The barkhan range, adjoining the Amu-Daria, is the only

region of South-Eastern Karakum which chows a great mobility of its sands and a complete absence of vegetation. At this naturally arises the question as to the possibility and expediency of phytoamelioration conducted throughout the whole region, in order to change the bare barkhan rows into sandy hills bound by vegetation, to check their progress towards the cultivated valley of the Amu-Daria, and to make of them valuable pastures.

The properties of the shifting sands and of their vegetation, exposed in the first chapter, and the means of controlling the sands, discussed in the last, make us answer the questions as to the possibility of covering the barkhan sands throughout with vegetation, in the affirmative.

This is most easily realized on the outskirts of the barkhan range, bordering on the valley of the Amu-Daria, by throwing the waste irrigation waters into it and by planting in the thus moistened hollows the following trees:

<u>MORUS NIGRA</u>
<u>" ALBA</u>
<u>POPULUS EUFRATICA</u>
<u>" PRUINOSA</u>
<u>ELAEAGNUS ORIENTALE</u>
<u>ROBINIA PSEUDOACACIA</u>
<u>AILANTUS GLANDULOSA</u>
<u>SPECIES OF TAMARIX</u> etc.

HERBS, SHRUBS AND VEGETATION.

The phytomelioration of the barkhan sands beyond the spread of the irrigation waters would not be expedient. The psammophytes amid the barkhan sands develop slowly showing a high percentage of plants perishing through being covered up and blown bare. For this reason the working expenses will be considerable with little productivity.

The exploitation of these plantations as a source of fuel, or as pasture, is rather dangerous during the first 2-3 years. The thinning of the vegetation cover, furthers the cause of the wind so well, that during a short time the results of prolonged work will be annihilated. Besides, the need of phytomelioration in the central part of the barkhan range, with tree plantations on the border of the latter, will hardly be felt by the population in the very near future.

In considering the question of phytomelioration with regard to the whole barkhan range, not only the negative, but also the positive properties of the sands must be taken into account. The Amu-Daria barkhan range is the only region in South-Eastern Karakum, where fresh water may be found everywhere, in the hollows at a depth of several meters.

This may be explained not only by the situation of the barkhan range between the Amu-Daria and the Kalifsky Usboi, but evidently also by the greater mobility of the sands and the absence of vegetation on them.

With phytomelioration of the whole zone, the impregnation of the soil with salts and the shifting of the upper horizon of the underground water to a greater depth, must be expected; which will lead to great difficulties for the cattle growers. Thus the phytomelioration of the whole barkhan range would be of negative economical significance.

The sandy-clayey plain, with its nearly constant vegetation cover and relief, requires no phytomelioration for the present. As regards the sandy ridges, especially their Western part, it should be the purpose of phytomelioration, slightly to weaken the processes of growing over and the succession of plant communities connected with them, which may be accomplished by bringing back the former flocks of sheep.

The greatest need of phytomelioration is felt with regard to the transitional sand zone and the border of the barkhan range. It is absolutely necessary to come to the assistance of the local population in the feeble attempts to save its narrow strip of oasis from the annual encroach-

ment of the desert, which buries under its sands many tens of hectares of precious cultivated land with irrigated fields, gardens and houses.

GRAZING IN TURKESTAN.

When protected in their lower part by the trees growing in the hollows, the barkhans will gradually form their sands into a horizontal surface whose mobility after a few years will have so far decreased, that Aristida, Calligonum, Salsola Richteri, and other psammophytes, may be sown.

It may be expected that ten years after planting those hollows which are reached by the waste irrigation waters, or by the waters of the overflowing Amu-Daria, the barkhan sands will have lost their mobility, become covered with grass and turn into pastures.

The expediency of such phytomelioration of the 2-4 klm. broad bordering zone, admits of no doubts, as

1. It is the most reliable protection of the cultivated valley against the sands, if compared to the measures discussed in the last chapter;
2. It is rentable, as the working expenses are entirely covered by the profit from rational exploitation of the plantations.

With the rapid growth of the trees, this exploitation may begin 8-10 years after planting, and with utilization of the mulberry plantations for the silk industry - even after half that time.

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To extend this phytomelioration deeper into the sands is possible only in such places where the waste waters penetrate beyond the outskirts of the barkhan range.

Farther on, only psammophytes may be planted, while trees must be confined to the rare lowlands in the barkhan range, where the underground waters are near enough to the surface to form "sheshme" (sources).

The phytomelioration of the sandy hills with shrubs - psammophytes - may be conducted only for the purpose of improving the pastures. In this regard, special attention is due to the Astragalus ammodendron confirmans, which by its annual herbaceous shoots, up to 0.5 m. long, yields a considerable mass of rather good fodder, greedily devoured by the cattle.

Astragalus is widely spread on the sand hills, but as its self-dissemination is interfered with by the sheep, it was formerly of rather rare occurrence. Only at the present time, since 1918, when the sheep flocks were removed from South-Eastern Karakum, Astragalus has developed in great quantities. In view of the fact that the chief economical importance of the saxaul forests, consists, not in pastures, but in being a source of fuel, the phytomelioration of these forests may be reduced to their rational exploitation, from which the present vandalistic wave of utilization, varies very far.

C H A P T E R III. RESULTS OF GRAZING IN TURKESTAN

Paragraph 1. Forage and Water Resources.

Biblio: 1

The forage resources of the barkhan range are rather scanty in quantity, as well as poor in quality. Nevertheless, in times before the war, this zone was mostly populated by flocks of sheep with their shepherds and was utilized up to the limits of its forage resources.

This is explained in the first place, by the proximity of the densely populated valley of the Amu-Daria, with its numerous kishlaks, and afterwards by the abundance of water. The underground waters of the whole barkhan range, bordering on the Amu-Daria valley, are rather fresh; they are found at an inconsiderable depth and are readily available, especially at the bottom of deep hollows, where they are found at a depth of 1-2 m. The digging of wells is not easy, for which reason they are seldom permanent and most frequently are renewed every year. Wells are met with repeatedly at a distance of 3-5 klm., and not more than 8-10 klm. from one another.

In deeper valleys, the underground water is not unfre-

quently so near the surface, that it almost oozes through.

Where at the bottom of a hollow, gray sand crops out, enriched with humus from the luxuriantly developing vegetation, the shepherds dig the loose earth with their hands (without spades) and find fresh water at a depth of about 0, 3-0, 5 m. The type of husbandry in the barkhan range is about 1-3 hundred sheep per well.

The intensive utilization of the barkhan sands adjoining the Amu-Daria for cattle-growing, indubitably augments the danger represented by these sands for the cultivated land of the Amu-Daria valley.

The cattle, eating the scanty vegetation of the barkhans and continually digging up with their feet the sand in the hollows, which under the influence of developing vegetation and outcrops of clayey areas, begins to be covered with a crust, retard the natural process of growing over of the sands and maintain them in their bare condition.

The last chapter describes the damage wrought by the bare barkhan range in the places where it approaches the kishlak zone. Therefore, the unimpeded development of the processes of spontaneous growing over in this part of the barkhan range is of essential economical importance, and it should be recommended to the population not to utilize the wells nearest to the Amu-Daria valley for permanent cattle-growing.

Paragraph 2. The Distribution of the Barkhan Sands in South-Eastern Karakum and their Importance.

The barkhan range near the Amu-Daria is the only part of South-Eastern Karakum, which is throughout occupied by barkhan sands. It is only this part which is up to now in the early stage of development of the sand, where the sands are in the state of bare shifting, barkhan rows. The remaining part of Karakum, constituting 5/6ths of the whole area, shows further stages of development of the sands and is characterized by the development of processes of spontaneous growing over. The sand being bound by vegetation, passes over from the state of moving barkhan rows to immobile hillocks, gently sloping hills and ridges covered by plant communities which succeed each other during the further development of the processes of growing over.

As a result of secondary deflation developing through the pasturing of cattle, the work of burrowing rodents and, in some places, through the desiccation of the upper layer by the processes of growing over, there are areas of secondary barkhan sands, occupying a comparatively small acreage and forming islets amid the sands bound by vegetation.

The range of barkhan sands plays in the life of the country, a negative rather than a positive role. Already the relief of this range formed by long (up to several hundred m.) high (4-18 m.) barkhan rows showing a base from several tens to a hundred and more meters wide, and long hollows, between them, approaching the barkhan rows, in their width, makes it impossible to adapt this range to cultivation, however high the development of irrigation. The grounds of the range, which in the barkhans consist of homogeneous, well-sorted aeolian sand, with a minimum amount of small particles, and in the hollows of more coarse-grained sand and thin layers of reddish clay underlain by gray sand, which occupy but a small acreage, - are the least suited for cultivation.

One cannot say, however, that it would be useless to conduct water into the barkhan range. In a series of projects concerning the channels on the left bank of the Amu-Daria, with a channel passing in close proximity to the barkhan range, or at its very foot, the waste water will have to be led off. It would not be expedient for the solution of the sand problem to convey water to the spot and to lead it off again, instead of throwing it into the sands and thus accelerating the processes of growing over.

Paragraph 3. The Attitude of the Population and the Means of Controlling the Sands.

The inhabitants of the Amu-Daria valley have been compelled long since to protect their houses, gardens, fields and "aryks" (irrigation ditches) against the sands. To keep off the leaders of the barkhan range, having come near the farm land, the population of Adji and of other kishlaks, builds "duvals" up to 4 m. high and several tens of meters long. These duvals are usually placed across the end of a narrow, not very high tongue of sand, and during the first time indubitably protect the farm, by retaining the sand.

But afterwards, the sand on the side of the barkhan range, begins gradually to creep up the wall, reaches the top and rolls down. Not unfrequently, a part of the duval breaks down under the weight of the sand and thus opens a passage for the latter.

But the chief measure taken by the population is the protection of the vegetation covering the sand. The inhabitants of the kishlaks are very careful as regards the shrubs covering the border hills and, with rare exception, do not cut them down for fuel. The latter is usually brought over on camels from the sand hills near Uzboi, situated at 16-30 klm. from the kishlak.

The sand plants, however, which are of forage importance, are cut deep by the population almost everywhere in the transitional zone. The first place is occupied by camel thorn (Alhagi camelorum Fisch.) which is stored up in great quantities as winter fodder for the camels. The population cuts it down everywhere, beginning with the sand hills which have already reached the "duval" and begin to cover it up. Before the camel thorn is cut down, all sandy lowlands, the small hillocks, even the middle-sized ones, show a green cover of Alhagi which not unfrequently forms continuous thickets.

After cutting which begins, in the late September and continues to October and even to November, the above-mentioned places are laid bare and the sand is loosened; as in order to preserve the entirety of the plant, it is cut 5 m. below the surface. In October, the winter winds, blowing from the South-East, are already setting in and in connection with that, the sands change their receding movement into one direction, towards the kishlaks zone.

The "Afghans", as the usually very strong and stubborn South winds are called, drive before them a cloud of sand from the loosened surface deprived of its vegetation cover, and the barkhans accelerate their progress.

In view of this intensive widening of the desert area

at the cost of the cultivated acreage, taking place from Kerki to Palvart, where every year not less than 7, and perhaps about ten hectares of irrigated land, with their fields, gardens and buildings, are annihilated, it is necessary to take prompt measures in order to protect the kishlak zone against the advancing sands.

The chief role in these measures must be naturally played by plants binding the sand. The best in this regard are the psammophytes-pioneers, the most important of which, Aristida pennata Trin., variety Karelini Trin. and Rupr. and Calligonum caput-Medusae Schrenk. may be found in these places.

With possible irrigation, it would be expedient to replace the psammophytes by more vigorously developing species, if only they possess the faculty of the psammophytes to grow rapidly through the sand which covers them up, and emit the necessary adventitious roots.

Paragraph 4. Results of Grazing in Turkestan.

Biblio: 1 In the spring of 1925, the author organized, with the Geobotanist, E. P. Korowin, an expedition to explore the South-Eastern part of the desert, Kara-Kum through which the Turkmenistan U. S. R. government intended to build a canal for watering purposes; and promote and replace the vegetation and grazing, on the free untilled territories extending mainly between the lower part of the rivers Murgab and Tedshen. The main conclusions of the author are as follows:

1. The broadly extended, many million Hectares of Turkmenistan can be watered only by the Amu-Daria. The main irrigation canal must cover a length of about 250 kilometers, and has to run through a sandy, very hilly, undulating desert, of loose, easily washable ground; with large, salt-impregnated depressions, proximate ground water, raising then splitting earth masses, numerous wind-drifted masses of sand, etc. These are very difficult problems and the circumstances in the practice

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of irrigation are unparalleled in the entire world.

2. Running of the irrigated water through the desert Kara-Kum, will be considerably facilitated, when the sandy and level plain will be watered at the same time; and when near to the canal, oases will be settled respectively, builded up with an area from about 40,000 to 60,000 Hectares, and naturally well watered.

3. The South-Eastern part of the Kara-Kum is a desert of a very particular kind, rich in ground water (water level); and besides has abundant winter and spring rain water. The water is accumulated in the so-called Kaki's (cavities) for drinking purposes of the grazing animals. The predominant part of this desert, consists of grass swards with several other plants here and there, on newly leveled spots, possessing a favorable formation of ground (desert ground formation) composed of sand and spongy sand "Swetlosjomy" (light soil types). In this fundamentally chief soil type primitive salt species, such as "Takyra" and

salt marsh, are scattered in large depressions, so-called "dry river beds"; and in the present formation of moving sand. In respect to new creations of desert sand, the view point of "Repetek-Gypsum articles", is very interesting and the frequently recurring little crustaceous aggregations of the water retaining silica earth, is evidence concerning the possibilities by solution and translocation of the silica dirt - building up a desert.

4. Many authors describe this desert as an origin of the wind. Perhaps it is possible. It is characteristic that without the existence of loam-containing middle strata, the presence of fragments of some mountain substance in the form of rolled and ground stones, various pethrographic, volcanic and Neptunic creations of the lower grayish and the upper reddish-yellow sand elements. Apparently the herewith described part of the Kara-Kum has been created by water sedimentation in the earliest period of the post-Tertiar epoch. Later, it has been changed, especially by the activities and influence of the human race and took on the present features of a here and there heavily overstormed sand desert, folding large masses of chain-hills and moving sand.

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By: N. A. Dimo.

CHAPTER IV. VARIOUS PLANT MIGRATIONS.

Biblio: 1 A plant is one of the best reagents upon the conditions of the environment and just in this respect the vegetation of the Pamir proves to serve as one of the best instances responding to the total sum of severe physico-geographical conditions, peculiar to this country (the height of the place, the dryness of the air, the mean precipitations of 70 mm., 90 per cent of them being snow and hail, strong fluctuations of temperature, the negative mean annual value of the great isolation and an immense difference in lighted and darkened areas, the winds of extreme power and of more or less constant directions, the conditions of the substratum proper soil we have but in few places, mostly only in regions of the development of meadows).

With regard to the height one might expect here the development of plants of the conditions of an extremely continental climate; we have here an Alpine zone nearly reduced to a small number of separately scattered representatives and very inconsiderable areas of Alpine meadows, being grouped or situated on abundantly moistened and usually protected regions along the sources of streams, along the water courses at the end of a glazier, on the moraines

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in places of infiltration of water from thawing snow in narrow, moistened valleys, upwards under the points of mountain passes on the border of eternal snows under corresponding conditions of soil and protection against winds. All the other regions, save the bottom of a valley in those parts that are abundantly moistened by current and in most cases meandering streams, of the protected slopes of northern expositions and of insignificant areas with pebbles and gravels along streams with shrubberies, bear the character of a desert landscape.

With respect to the relief, we come across the vegetation of slopes, as well as the vegetation of the bottom of a valley and closed ravine, as long as one has to deal with a mountainous country.

Within the limits of these fundamental habitations the character of the vegetation depends upon the character of the substratum, the rocks having formed it, and upon the degree of moistening first of all, whereby under the given conditions of the Pamir, the moistening plays a very important role:

1. On rocky slopes.
2. On stony rubble malkoziom (small grained)

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        (     Immovable
        (
  Slopes(     More or less movable(with influence
        (                         (of moving stones
                                  (of a character of
                                  (moving stones.
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3. On soft slopes where projecting rocks and separate fragments are quite, or nearly absent, the substratum is melkoziom (small grained soil), or rubbish.

II. In valleys:

1. On the sloping down rubble - melkoziom submountainous zone.
2. On flat melkoziom, rubbish parts of the valley, sometimes with areas of the takyr type; on areas in fact of various origin.
   (a) On flat rubbish on bed rocks, that is to say, existing here nearly from the very beginning.
   (b) By appearance nearly similar in character to the substratum, but evidently of an alluvial and drifty origin, gotten from the surrounding mountains, not seldom, taking them over as along the Karasu, opposite the Jamantal.
3. Slightly hilly regions of ancient moraines, also frequently with takyrlike areas.
4. Undulating hilly areas on the bottom of lake basins, connected with ancient lake deposits, being blown over at the top with sand from a small grained, to a large grained, type of gravel.

5. On melkoziom areas along the rivers on metamorphosed soils, usually resting upon pebble alluvium areas and covered with wet and salty meadows.
6. On melkoziom areas around lakes often with wet and salty meadows.
7. On pebble and pebble-sandy areas along rivers (modern river terraces).

Strips of Alpine meadows along streams, and small meadows areas at the issue of warm springs may be without strong dependance upon the relief as well as groupings of plants submerged in water, connected with the lakes of ravines, also with small lakes, and shallow ponds at the ends of the glaciers, near the pass points with ponds, which formed themselves in the upper parts of narrow little valleys in connection with lateral moraines, and besides with streams of warm waters from hot and differently mineralized sources.

As the most characteristic vegetative groupings, from which one might deduce the whole variety of vegetation of dry habitations of the Pamir, doubtlessly prevalent regarding the size of the surface taken in by them, one might consider the vegetative

groupings of the bottom of the valley in part 1 and 3 of the habitations.

There are the vegetative groupings, classified with regard to the prevalence of the following:

1. "Teresken" - Eurotia ceratoides.
2. Stipa and Artemisia

   Stipa orientalis and Artemisia Kuchakewiczi; on areas connected with the distribution of the latter. Not rare are mixed groupings with an equal number of components, where Stipa, Artemisia, Astragalus Muschketovii, Oxytropis chiliophylla and

   " Poncinsii

   Eurotia ceratoides

   Acantholimon diapensioides and partly

   Christolea pamirica play nearly the same role; and finally,[1]
3. Associations with prevailing Christolea pamirica as a landscape plant.

   The first two vegetative groupings: The first one, chiefly connected with granite and quartz masses and

1. It is of interest to notice that most of the enumerated plants, especially when sufficiently old, have markedly characteristic forms of "fairy rings".

the second with slate and lime masses are widespread; the second type with some modifications being still more widespread than the first one.

We have a very well developed soil lichen cover, mostly of the incrusted type in the above-described groupings of flowering plants in the bottom of valleys, on rubbish malkoziom, or nearly malkoziom areas.

The lichen cover occurs here throughout the whole area nearly to the pass points, providing the corresponding conditions of relief and soil. It is especially well developed on soils with characteristic polygonal fissures.

Here the lichens are distributed almost everywhere on Northern and Western-Northern sides of plant nushlets and also in form of stripes along the fissures of the polygons, parallel to its rubbish border. Sometimes the whole polygonal area is occupied with the lichens.

Incrusted lichens among which prevails the forms of the Acarosporaceae, as also the Endocarpaceae, Diploschistaceae and partly Placodium and Aspicilla, especially in the presence of sometimes small groups of mosses, give a percentage of cover of the surface with lichen cr lichen-moss cover, approaching to 50 per cent and even exceeding that value.

This fact may be in connection with the circumstance, that lichens are spreading with their thalli, not only on

melkoziom surfaces, but often cover small, stony rubble fragments.

The lichen cover in regions of spreading of a rubble melkoziom zone, takes place within the borders of teresken and *Stipa*, *Artemisia* and similar associations.

From the said type of vegetative groupings one might find the direct transition to the vegetation of slopes, which as regards specific content gives us nothing new and is only a little richer in species than the above zone; the prevalence of these or those forms is here connected with the exposition and the character of the substratum.

As less developed vegetative landscapes of the Pamir prove to be the landscapes of "abundantly moistened habitations" (Knorring), such are above all the meadows along more or less large streams and meadows of lake deep valleys, Alpine meadows, meadows near warm sources, also shrubberies and open grass associations of a riverbed - vegetative groupings sufficiently characterized in the literature.

B I B L I O G R A P H Y   A N D   R E F E R E N C E S

1. "The Vegetative Landscapes of the Pamir".
Library of Agriculture. 54 - T 18 B - Fasc: 12.
By: Rajkova Hilaria.

Paragraph 2. Various Plant Migrations in Turkestan.

Biblio: 1 The reasons of plant migrations can be summarized as follows:

1. It is necessary to distinguish between two types of plant migrations:
   (a) Successive
   (b) Autonom

2. The successive migration is performed in the same ecological manner as is signified by signs of successions and depends by all means, upon the grade of specialization of the organisms, from the ecological expansion and continuation of the surroundings; and furthermore, from the grade of isolation of single units of topographical successions.

3. The autonom migration, indicates an expansion of consanguinity (kinship) in various ecological circles and will be apprehended in the natural order, by ground studies of geno-ecological references. The reality of this migration will be substantiated through extended appearances of ecological substitutions, in regional or stand

tables.

4. The geographical ways of autonom migrations are dependent upon the distributions of ecological surroundings in the indicated season.

5. The ecological adjustment depends upon the tendencies of Genotypes, and upon their capacity for migration.

6. For some types, whose genesis can be traced in the Mediterranean, the autonom migrations are developed in frames of differentiated thermical races.

7. By distinction of ecological factors, it is necessary to keep in mind two main groups, as follows:

   (a) <u>The ontogenetical</u>, with their influence on the organic.
   (b) <u>The phylogenstical</u>, whose significance is proven by the process of ecological differentiation of Genotypes.

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1. "Various Plant Migrations in Turkestan". Library of Agriculture. 511 - T 18 B. Fasc. 16. By: Enf. Korowin.

Paragraph 3. "Die Vegetation des Chodochenter Rayons der U. S. R. (Das linke Ufer des Flusses Syr-Darja").

Biblio: 1 The research work done heretofore is the result of a summary of geo-botanical field researches, conducted along the left river bank of the Syr-Darja, in the Rayon of Chodeshenter, with an area consisting of 77,000 hectares.

Reasons of plant migration:

1. The larger portion of ground in the Rayon Chodschenter has been ploughed for ages and turned into particles of cotton, grain in large part, and to orchard and vintage cultures.

2. The original and natural plant communities remained, because for some reason they have not been ploughed. The reason which may be considered unfavorable, are as follows:
   (a) very stony substrata
   (b) elevated topography with steep overhangings (declivities).

(c) Salty ground

(d) Deficiency of water for artificial irrigation, required for a certain area.

3. Basically, the predominant husbandries are divided into two groups, concerning the vegetation blanket of Chodschenter Rayon, which are as follows:

(a) Natural vegetation

(b) Cultivated vegetation, with weeds.

Within the borders of every single group, the specific, typical plant associations occur conspicuously.

4. The Vermut Steppe (Artemisia maritima) plus Carex stenophlyya and several other ephemeral plants, are on the extended western deserted barren light earth slopes of the Turkestanian mountain-chain, which means a fairly good spring and autumnal pasture, secured to horses and shepherds.

5. The stony Vermut salt-wort (saltpetre) steppe of the Turkestan mountain chain (Eastwardly from the Autschi mountain chain) extends on a very stony light earth, originated by stone

rolling downpour. The vegetation is very sparce, producing a few ephemers which are readily suppressed.

The most potentially extended species are the following:

ANABASIS ERIOPODA

SALSOLA RIGIDA

ARTEMISIA MARITIMA

securing a very sparce pasture for goats and sheep.

6. The Vermut salt-wort desert lying on a tertiar strata is enriched by a proxy (Zigophyllum miniatum), of the specific flora, and extends on the Digma and Topsar Hills, securing in spring and autumn, a very sparce pasture for small domestic animals.

7. The salty vegetation is located on the lowest terraces of the river Syr-Darja, on a water marsh ground and on the salty grounds in a complex with spots of vegetation on sand-blown hills. The vegetation of salty ground, promises a very good summer pasture, for camels, and an autumnal and winter pasture for the rest of the domestic animals.

8. The cultivated vegetation, with the weeds, builds up, about 70 per cent of the researched Rayon. Dominating,

are the Vermut fallowlands with a quantity of old growth, which is intermingled on the stand of Vermut steppe, with Carex stenophylla and other ephemers.

On the fallowlands, a large variety of the vegetation is under observation, and is placed in systematic order. Many ephemers are developed in the spring. Ruling in the summertime, we find the Artemisia maritima.

Among spring and summer vegetation, several weed-plants are occurring in the fallowlands. The grade of the blanket flora reaches from 8 to 30 cm. The fallowlands are producing very good pastures for small domestic animals, besides a sufficient amount of grass fuel.

9. The cultivated cotton, grain, barley fields, gardens and vintages are developed, being well supported by an artificial irrigation and a favorable climate; and are very productive, thanks to the particular care bestowed, and are almost weedless.

10. The rice fields are in complex with the swamp-vegetation of the lower rivers of the Syr-Darja, on an artificial watered marsh-ground, supported by a highly leveled and widely dispersed chain of water tables. These fields contain more weeds than the others.

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1. "Die Vegetation des Chodochenter Rayons der U.S.R. (Das Linke Ufer des Flusses Syr-Darja"). Library of Agriculture. 511 - T 18 - livr. 18. Bulletin de l' Universite De l' Asie Centrale. By: M. Sovetkina.

Paragraph 4. "Ten Years of Investigations of the Flora and Vegetation of Middle Asia".

Biblio: 1 The following data concerns the flora and vegetation in different parts of Middle Asia, from Kopet-dagh to the Alexander Mountains.

The most important phytogeographical result is the stating of the changing character of the flora of Middle Asia as a consequence of perpetual changes of its edaphical features. According to the author, the flora of Middle Asia is now found, not in a statical, but in a dynamic state; and forms, and new species, continue to originate up to the present time.

The sandy desert especially attracts the (author's) attention, because it is the most peculiar phenomenon amongst the types of Aralo-Caspian deserts. Its vegetation is widely different from that of clay, saline, or stony deserts, and gives us a sample of ecologically and genetically isolated flora in a great degree adapted to its particular conditions of life; the structure of flying fruit is the most interesting biological feature of this flora and the question of the cause and way of

origin of this feature should lead to the capital problems of evolution and Phytogeography.

Lastly, the author gives an outline of the history and development of the flora of Middle Asia since the upper Cretaceous time. From then until now, the present Tienshan and Pamiro-alai was and is land bordering upon the old Angara continent, presenting peneplain with more or less arid climate.

At the far east end of Tianshan then, there were deserts containing some of the old desert types of plants, originally from Africa (from Gondwanaland) for instance, Zygophyllum and Nitraria. The remaining parts of this land were covered with an ancient Mediterranean flora resembling that of the present time.

After the Thetis had retired from Central and Western Asia, the Aralo-Caspian plains took on (in Pliocene) greatly desert-like features, and were over-covered with a desert flora coming

1. From South-West (from North-East Africa); and
2. From Easr (from the old deserts of Tianshan) and having a strongly expressed African type. This was chiefly the vegetation of stony gypsiferous soils (hamada) and it became extinct at the end of Tertiary by the development of

sandy deserts which inherited some of the pliocene types of hamada.

At the same time, the Mediterranean flora of Tianshan and Pamiro=alai, became more and more xerophilous, poorer and poorer on the subtropical mesophilous forms. The influence of the Ice Age leads to the same results, and by it the Northern recent (boreal) types were allowed to penetrate largely into the then arisen mounts of Middle Asia. The old mesophilous types, such as Ostrowskia, Trigonotis, are preserved now only in a few places on the mountains of Middle Asia.

The restoration of an arid climate after the Ice Age was the cause of the reflourishing of xerophilous desert flora, but it was and is a new flora which had its origin from the old African and from the old Mediterranean types of Tertiary. This is so-called Iranic flora, which now reigns over the whole of Western Asia from Syria to Mongolia.

B I B L I O G R A P H Y   A N D   R E F E R E N C E S

1. "Ten Years of Investigations of the Flora and Vegetation of Middle Asia".
Library of Agriculture. 56.9 - Sr. 2.
"Bulletin de C'Institute de Pedologie et de Pedologie et de Geobotanique".
By: M. G. Popov.

Paragraph 5. "Seeking Plant Immigrants".

Biblio: 1 Bachar-den, in Turkestan, was visited - a small town near to the mountains, where some fine native vegetation was said to occur and some interesting plants can be found, as for instance the ornamental

EREMURUS (a few species of)

TAMARIX

ACER

CERASUS MICROCARPA

PRUNUS

RHUS

INTERESTING GRASSES etc.

It can not be said that the first impressions of Central Asia are so very pleasant, after having seen so much of the beautiful Caucasus. There is much heat, much dust, much vermin here, and relatively little comfort - even washing water is hard to get.

The vegetation is, as could be expected, not very varied in general. Around the houses and railway stations one finds mostly our

ACACIAS (ROBINIA PSEUDACACIA)

AILANTHUS GLANDULOSUS

ULMUS PUMILA

" CAMPESTRIS

POPULUS BOLLEANA

SOPHORA JAPONICA

KOEIREUTERIA PANICULATA

MORUS ALBA

GLEDITSIA TRIACANTHOS and here and there an

OSAGE ORANGE (TOXYLON POMIFERUM)

All those trees are periodically irrigated. If not, they die within one or two years. In Krasnawodsk, however, where it is quite mild in winter, a beautiful flowering bush

POINCIANA GILLIESII

thrives with very little irrigation

ELAEAGNUS ANGUSTIFOLIA

POPULUS DIVERSIFOLIA and a species of

SAXAUL-BUSH (AMMODENDRON?)

also need very little water. There are, however, apparently few trees to be found that resist the aridity of the Central Asian plains, where hot summers are followed by cold winters, while high winds blow very frequently both winter and summer.

The trees that looked the best are the native form of

ULMUS CAMPESTRIS

The Chinese AILANTHUS GLANDULOSA and the North American

ROBINIA PSEUDO-ACACIA

In Merw there is a pretty park, where tall specimens of poplars occur (<u>Populus alba pyramidalis</u>); and some fine large specimens of the "Karakach" (<u>Ulmus campestris umbraculifera</u>); very striking trees they are, with their umbrella-like shape and a dense mass of rather small foliage. These trees will be highly appreciated by our settlers in the desert regions. These elms, although drought-resistant, have to be watered. Other trees in that park are the following:

<u>ACER NEGUNDO</u>
<u>ROBINIA PSEUDO-ACACIA</u>
<u>SOPHORA JAPONICA</u>
<u>AILANTHUS GLANDULOSA</u>
<u>GLEDITSIA TRIACANTHOS</u>
<u>SALIX BABYLONICA</u>
<u>TOXYLON POMIFERUM</u>
<u>CATALPA BIGNONIOIDES</u>
<u>MORUS ALBA</u>
<u>CYDONIA VULGARIS</u>
<u>PRUNUS ARMENIACA</u>
<u>PIRUS COMMUNIS</u>

The desert around Merw is quite interesting. Besides the camel's thorn, there also grows a very spiny, acacia-like plant, in the desert. It is not ugly as a solitary plant,

but it is a bad weed on all untrodden places; some Lyciums occur also, and a few minor plants, but as a whole, the desert flora is not rich in species. One finds, however, in the desert around Merw many canals, some still in use, some dried up; they say that some of these man-made water courses are 3000 years old and if so, there is surely "little new under the sun", so far as irrigation is concerned. The present people here have a great hope for the future as far as the bringing-under-culture of desert land is concerned. Large, new canals are being dug, new settlements started, and with present high prices of cotton, people can be comfortably off in some years time.

It is most interesting to see how the tall bushes of

CALLIGONUM CAOUT-MEDUSAE
" ARBORESCENS
SALSOLA RICHTERI
HALOXYLON AMMODENDRON

have grown into some sort of a forest in a soil that is almost pure sand and, worse than that, a moving sand! And it is even stranger to see how a few seeds of the Chinese Tree of Heaven (Ailanthus glandulosa) have found lodging between these real desert plants and have grown vigorously too, and are of fairly good sizes now.

The real Saxaul will grow. To arrest a shifting sand-hill, one first has to plant various Calligonums, then Salsola Richteri and after that Haloxyon ammodendron. Of the Calligonums there is an immense mass. Up to the present, fifty-seven different species have been found and there are still more. However, only thirty have been scientifically determined and the others will come in the course of a few years.

Some of these Calligonums are strictly local plants and may not readily bear acclimatizing; at least the species from around Oremburg and Astrakhan do not stand the long, intense heat at Chartchui.

After having seen the large plantations, where the plants are now spreading rapidly and require practically no care any longer, we paid a visit to the nurseries where seeds are sown and young plants raised. They had experienced a very late frost and the stand of the plants was not what they wished it to be; still it was interesting to see how the sand was held in check by long straws stretched over it; this kept in place again by little sticks set across it at the ends.

Hedges of Tamarix and of the wild form of Elaeagnus Angustifolia held the great winds off. The seeds are all sown in the autumn and have to be kept moist as long as they have not germinated; when once above the ground, however, great care is necessary in keeping them almost dry, as otherwise they perish.

[illegible]

[illegible]

[illegible]

On a few places in Turkestan is seen some beautiful Eremurus and yellow larkspurs, but in general the mountains were devoid of vegetation, save some Astragalus and a Capparis spinosa and some Artemisias. The soil in these high regions near Lake Kelikulan, at 10,000 feet altitude, is sterile and the growing season very short, for the snow melts away in early May and returns again at the beginning of September. Still one finds there masses of the following:

JUNIPERS (JUNIPERUS FOETIDISSIMA)
BARBERRIES
BUSH HONEYSUCKLES (LONICERA)
YELLOW ROSES (ROSA XANTHINA)
A MOUNTAIN ASH (SORBUS TRIANSHANICA)

Besides various herbaceous plants like the following:

EREMURUS
GENTIANA VERNA
LEONURUS (?)
SEVERAL COMPOSITAE etc.

In the immediate neighborhood of Kokand one sees field after field covered with cotton, alternated with alfalfa and "jugara". This last can stand considerable alkali and may be of some value in alkaline regions with long and hot summers.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

One also notes the masses of Oleaster trees that are everywhere around the fields and along watercourses. These Eleagnus trees exhibit a remarkable variation in general habitus, productivity and sizes of fruits. The bigger part of them all seem to be seedlings, and are planted apparently only as shelter material; at least the fruits of many are too astringent to be edible, and even of the larger fruited forms, only here and there are the fruits collected. It is, however, a beautiful tree in the landscape, especially the silvery-white forms with the narrow, long leaves.

B I B L I O G R A P H Y   A N D   R E F E R E N C E S

1. "Seeking Plant Immigrants".
Library of Agriculture. No. 442.8 Am 3.
The Journal of Heredity. Volume 5.
By: Frank N. Meyer.

Paragraph 6. "Die Vegetation des Rayons des Gebirge Chobdun-Tau und Karatscha-Tau".

Biblio: 1 The appended research is a summary of a short expedition on the medium-sized mountains, Chobdun-Tau and Karatscha-Tau and near-lying plains. The purpose of the expedition was for investigation of the vegetation and pasture flora. During the time of research work, the mountain area, as well as the meadows, was crossed several times.

The mountain chain is composed of metamorphous slate strata, sand and loam, originated in the paleozoic era. The climate is distinctly continental. The distribution of precipitates and temperature during the year, is extremely irregular. The floor of nearby leveled plains is composed mainly of gray dirt, which is spread widely at the Southern mountain sections around the station of Rostovzevo, Gasira and their valleys.

In the mountain, dry, stony slopes, interspersed with refined humous substrata are encountered.

The researched territory covers a plain and mountain region with an absolute elevation, varying between 690 and 1714 meters; therefore, apriory, a change and migration of plant vegetation occurs, as the elevation changes with the sea-level.

There can be found on the leveled plains, limy half-deserts, transit territories to several dry steppes in the mountains on areas with several grass species, the vegetation of stony slopes, Bodkin and meadow-grass steppes, the lower belt of shrub trees; and finally, the vegetation of river tracts, running across the valleys.

THE LIMY SEMI-DESERTS.

Limy semi-deserts are occurring on the Southern slopes of the Chobdun-Tau mountains. They stretch out to 840 meters and run through the transit strip, into the dry steppes, with various grasses. The vegetation is generally uniform and is composed of annual and biennial species, the latter occupying from 40 to 50 per cent of the total top vegetation (which otherwise covers 100 per cent of the ground). The plant blanket is composed of the following social favoring groups:

CAREX HOSTII and
POA BULBOSA variety VIVIPARA

which are interspersed with a series of perennial plants, as follows:

PSORALCA DRUPACEA
ALHAGI CAMELORUM

SOPHORA PACHYCARPA

PHLOMIS THAPSOIDES

Altogether, twenty-seven species have been observed, on an area of one hundred square meters.

THE TRANSIT STRIP OF DRY STEPPES WITH VARIOUS GRASSES.

The transit strip is emphasized on a basis of its botanical endurance and favorable ecological circumstance, regarding the development of plants as a result of limy semi-deserts.

A part of the plants for which research has been conducted in the limy semi-deserts, belong to the stand of a row of migrated plants, usually not found growing in this environment, such as the following:

AGROPYRUM TRYCHOPHORIUM the
heavily extended CONVOLVULUS SUBHIRSUTUS and
ASTRAGALLUS GLOBICEPS

From a botanical viewpoint, the latter ones are richer and more heterogeneous, than those of the limy, semi-deserts.

They are expanded up to the mountain, Chobdun-Tau, surrounding it in a circle and overlapping to the numerous grass steppes. Furthermore, there has been conducted a (plant) phyto-social research, because it is mainly important to know how far verified are the reports of Du Ritz and Oswald, re-

garding plant associations, and migrations, of Western Europe; also the findings of Uranov, about the Northern Steppes of Pensa adaptability to the plant conjunctions of Middle Asia.

Sedge and grass associations have been used for research purposes. Two test areas have been separated into two hundred and fifty square meters each, and on both, a meter long experiment plot (parcel) established (numbering altogether twenty-five), to determine the constancy of plants, where constancy K = 0 per cent.

Using the diagram with ordinates and abscissa, a curve has been established. Comparing the curves with the data given by Du Ritz, we find that they tally and are analogical to such an extent, they even repeat.

The constancy varies greatly and we can conclude that the enactment of constancy of plant species in the association as determined by Du Ritz, Oswald, Fries and Tengwall, regarding Northern Europe, especially in Scandinavia, are analagous to those of Middle Asia.

We have to rate as constant, species in our circumstances which occur not less than fifty per cent in the researched area. The constant ones, after the conception of Du Ritz (absolute constants), do not show all the characteristic properties of this, or any other association.

Under our circumstances, all associations would be determined through absolute constants and a row of constants interpreted through internal domestic ground circumstances. To determine the "area minimum" of an association unit, many places have been selected of different sizes. The result proves that constants, on some places being smaller than one square meter, are decreasing remarkably. One square meter (1 m^2) is the advisable surface on which all constants occur, and this area is an obligatory minimum.

THE VEGETATION OF MOUNTAINS

(REASONS OF MIGRATIONS)

The structure of plant carpet in the mountains is more complicated, because there is a greater entangled conglomeration of ecological terms, than on the low-lands.

It is notable what influence different kinds of climatic conditions have in connection with the raised elevation above sea-level, character of sub-strats, and exposure, etc., which naturally reflect on the plant stands.

THE VARIOUS GRASS DRY STEPPES.

The vegetation of the various grass dry steppes, is characterized by the presence of a row of perennial reigning formations, as follows:

AGROPYRUM TRYCHOPHORUM

PHLOMIS THAPSOIDES

In addition to these are the widely extended perennial plants as follows:

COUSINIA RADIANS

and sometimes EREMURUS OLGAE

CENTAUREA VIRGATA variety SQUARROSA

COUSINIA DECURRENS

The constancy of species of this belt, produces curves which are similar and tally with the curves of the transit belt of the "various grass" dry steppes.

VEGETATION OF ROCKY SLOPES OF THE PREMOUNTAINS OF CHOBDUN-TAU AND THE MOUNTAINS, KARATSCHA-TAU

The conducting plant-groups took up stony substrata. They are well accentuated in the Karatscha-Tau, and partly in the Chobdun-Tau, covering the divisions of these mountains. This notable community joins mainly

ARTEMISIA MARITIMA

The vegetation covers only 75 or 80 per cent of the ground; sometimes considerably less. In this belt above, are the Wermut and Centaurea virgata variety squarrosa, and the migrated plant,

ASTRAGALEUS BACTRIANUS is widely extended.

VEGETATION OF THE CHAPARREL

The chaparrel belt is inadequately designated as the lowest strip of the Forest Zone. Many shrubs are occurring, such as the following:

AMIGDALUS SPINOSISSIMA

ROSA "

ACER FEDSCHONKOANUM

CRATEGUS MONOGYNA

ROSA CANINA

ULMUS CAMPESTRIS

The vegetation is especially varied, on account of the complicated conglomeration of ecological circumstances, such as the combination of stony substrata, the mountain xerophytes, composed of the largely extended

ACANTHOLIMON ISKANDERI

and other species. The following association, of Bodkin and Panicle, is composed of the following:

SLIPPA SUBBARBATA and

POA BULBOSA variety VIVIPARA

They occur even on the mountain-top of Chobdun-Tau, at an elevation of 1550 meters above sea-level. The last plant-group of the researched area, is the vegetation of humid valley margins. This vegetation develops in narrow strips, a-

long the mountain creeks, with very humid ground, and is generally composed of the following:

JUNCUS GLAUCUS

MENTHA SILVESTRIS

and on the periphery of rivers, by the briers of the following: PEROVSKIA SCROPHULARIAEFOLIA

and DATISCA CANNABINA

It must be seriously emphasized that the researched vegetation, on account of interference of humans, resulted in a noticeable change and migration, with the up-rooting of thickets and trees for fire purposes.

C O N C L U S I O N S

1. The research work concerning the families of various grass steppes and the transit strip to the lime half-desert, of the mountain chain of Chabdun-Tau, proves that, by discovering an association based on a certain quantity of constants, as Broekman has done, those species have to be rated as constants if they occur on the researched area, not less than 50 per cent.

   The constants collected by Du Ritz, under our circumstances, as for instance, solid plant vegetation, and their exceptionally changeable stability, do not have all the typical characteristics and marks of an association.

2. The regulation of constancy, as established by Du Ritz, Oswald, Fries and Tengwall, is peculiarly useful concerning middle Asiatic associations.
3. The area minimum of an association of hidden families in transit strips of limy half-desert, to the dry steppe with various grasses, is a surface, with an area of one (1) square meter, after Brockman's assumptions of constants.
4. The cooperation of floral unity, with respect to a family of the transit strip, amounts to 29.8 per cent, which proves how changeable and migratory are the floral ~~permanency~~ bases of some ground units, just as well as single families of this Rayon.
5. The insignificant gradation of the constant curve, as Du Ritz defines it, can hardly be made responsible, for the result of deficiency of the material.

In every association occurs a certain "complex", composed of incidental, rather than characteristic species. This is accentuated unusually concerning circumstances of Middle Asia, thanks to the complicated conglomeration of ecological conditions. These results include only a community of relatively small area.

It is almost certain, that with further research, data of another phyto-social structure can be obtained in Middle Asia.

(The following is an abstract from the subject - see Biblio: 2).

In this present work, we are seeking to give an answer to the question of the "Rhythm of Plants", occasioned by their transportation (migration) from extreme conditions of one sort, into the opposite extreme.

Here it is not relevant to record the "static of appearance", as such, but mainly refers to the "Dynamics of its Rhythms". We approach Phenology from the standpoint of the influence of ecological factors on this rhythm.

The material of this comprises data of five years' observations concerning Phenology of some single points of Middle Asiatic flora, representing several botanical-geographical Belts, with specific ecological conditions.

With the presence of sub-species and sub-formations, we are able at first glance to compare certain types with others. The ecological quest means, that species we operate with, would be classified only by their fitness to the particular plant-belt, when data of such phases, or some other development of plants, is compared, and the "Dislocation of Phenology", settled in this way; the influence of these, or other factors, on the Rhythm can be shematically secreted.

This kind of movement can be styled "Ecologic-Phenological effects", pointing out digression by development of plants in botanical gardens, in comparison with the periods of natural circumstances. This deviation can be directed either from one side or the other, as under normal conditions, the development begins earlier or later. In the first case, our ecologic-phenological effect is signed as minus (-), in the second one as plus (+). To indicate the difference, we consider as main factors, the following:

1. Temperature, and
2. Precipitation.

These factors appear as first-class agents, regarding the concurrent circumstances.

(That the light which varies with the elevation above sea-level, appears as a factor, can not be determined, on account of imperfect data).

To illustrate the ecological conditions, we have to follow the way of division of vegetative belts, since they characterize the territorial distributions, similar to formal ecological conditions.

In the meantime, when we distribute the meteorological data, like precipitation and temperature, on each belt, we may obtain very vivid physical characteristics of this belt.

We can observe in the plant communities, wide varieties,

concerning various groups; especially, Middle Asia represents a large number of belts, with exceptionally specific ecological conditions, ranging from sandy deserts, with a xerophitic flora, up to pine forests.

Summarizing the short prelude, the following matter can be pointed out:

1. All observations show an accomplished dependency of rhythm from external factors. This reliance is expressed by the migrations of rhythm in connection with the changes of temperature and precipitations.

2. In cases of comparisons, the movements will be stipulated as such that the majority of plants of considered ecological groups, from steppe-belts, up to the deserts of high mountains under natural surrounding circumstances, as estimated with the plants of oases, are retarded.

   Besides, this development progresses from the lowest belts, up to the higher ones, by which process the steppe plants are staggering from 1 to 43 days, and the plants of high mountain deserts, reach the peak in 111 days.

3. Quite separated are the plants of sandy deserts and limy half-deserts, in the sense of change of rhythm.

4. The plants of sandy deserts behave differently, so far as they develop sooner; and such is the case in limy half-deserts, under natural circumstances.

5. Similar occurrences have to be noted, in connection with the positive late temperature; and furthermore, we can add to our pheno-ecological conclusions, that the rhythm occurs as an inconstant measure to the researched plants, under the same, or similar conditions; and in some years, changes with the various meteorological conditions.

The above-described appearance of inconstancy in rhythm of plants, involves great interest from various points of view. As is known, there is existent, large Polymorphism innthe flora of Middle Asia, which is accentuated by the variety of species which, with their formal peculiarities, are fluctuating to morphologically inconstant types. It is very possible that these peculiarities are partly the result of high plasticity of the rhythm of plants. Likewise, it can be added that the ability of plants change their rhythmical habits, approaching the area of ecologically varied, but related species, facilitates in this manner, the process of hybridization. Of course, these actions occur theoretic-

ally, but there are no facts, with few exceptions, known to verify this.

Herewith, we shall point out some of the practical results of our researches, one of which is as follows:

The pheno-ecological material, opens new perspectives of organizations, to vast experiments, of acclimatization, naturalization, and migration of plants, and permits possibilities of mixing some elements in the flora, which may develop under various ecological conditions.

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Paragraph 7. "A Sketch of the History of Development of the Flora in Middle Asia.

Biblio: 1 To understand the various plant migrations, M. G. Popov presents a summary about the history of the desert flora, of the Old World. His assumption can be rated as follows:

1. The history of the desert flora of the Old World, (flora of Welwitschia). After considering the history of the flora of Welwitschia and its relics in Africa and especially in Asia (these relics are numerous in Middle Asia) the author arrives, in accordance with the views of Engler, by the following conclusions:

    1. The primitive flora of deserts as far as it concerns Angiospermae and higher Gymnospermae (Ephedra, Welwitschia) developed at first probably in Cretaceous or, perhaps, even in Jurassic times. Without doubt, the beginning of its history was bound to the history of the Gondwana land (Holonotis), which, on account of its structure, must have been of a desert character in the central part (see maps

of Arldt, Haugh, Kober, 17, fig. 43.46).

2. The most ancient development of desert flora, which we can discover at present, coincided probably with the end of the history of Gondwana, with the beginning of its destruction. The removal of the principal region of its development at Cretaceous time into the South hemisphere was determined just by the destruction of the central parts of Gondwana.

3. From this second period, which we can designate as ancient oceanic, or lemurian, the evident traces, the great circles of forms were conserved, such as Zygophyllaceae, the part of Rutaceae, Geraniaceae, Capparidaceae, Pedaliaceae; which I unite under the name, the flora of Welwitschia.

4. During the second period, it had its place and finished the exchange of desert forms between South Africa and South America and between South Africa and Australia. It would be more correct to say that in all these desert lands of the Southern hemisphere and on the continents which bound them, we find now fragments of primitive pre-tertiary flora which had been propagated on the uninterrupted ring of land which existed in Cretaceous time in the Southern hemisphere from Australia, through Africa, to America.

5. At the same period the African continent was added to in its Eastern side by vast land, which had the features of a desert. This land, Lemuria, or Indo-madagassian peninsula, together with the adjoining parts of East Africa, was the bridge over which the desert flora went from the Southern hemisphere to the North, to the Southern shores of Thetis, in to Central Sahara, Somaliland and Deccan; Socotra is a part of this land. On the ancient land of Tianshan and Mongolia which had then (Upper Cretaceous and Eocene) the character of a desert, the first desert plants from the flora of Welwitchia appeared. The rest of Arctogaea, being separated from the centers of development of desert flora by Thetis, had a mesophytic subtropical character and was the place on which the flora of Ginkgo developed.

6. (a) In this period the desert types of Southern hemisphere, such as Zygophyllaceae, Pedaliaceae, Moringaceae, were spread through Lemuria without break of their areas from the Cape of Good Hope to India, Arabia and Sahara; partly to Central Asia, Europe, and probably through the North Atlantic to North America too.

The Lemurian land itself was an important

center of development of desert forms (Fagonia, Resedaceae) which partly had been spread to the South into South Africa.

(b) At the same time, (and probably up till Pliocene), through the mountainous table-land of Eastern Africa, that is, somewhat towards the West of the Lemurian deserts, the interchanging of the less xerophytic forms, took place between the South of Africa and its North, Mediterranean region and West Asia. In this way the species of Erica, Pelargonium, Lotononis, went from the South of Africa to the North; Lepidium, Dianthus and others from the North to the South.

(c) By the destruction of the Lemurian land (in Eocene-Miocene), and by the lowering and drying up of the mountains of Eastern Africa, the South African flora was isolated from the flora of the old Mediterranean region.

7. (a) The third period of the ancient desert flora in the Northern hemisphere was connected with the disappearing of the Thetis and with the development in its place of vast deserts.

Such deserts were: The North and a part of Central Sahara, the deserts of Western Asia, of

lower Indus, Turan, a part of Mongolia and Kashgaria. In connection with the development (in the second half of Tertiary) of these deserts, the desert forms of the flora of Welwitschia, which were in the preceding period advanced to the Southern shores of the Thetis and here, partly developing further, they overflooded the new deserts of Western Asia and of Northern Africa; and gave to these deserts a type strictly African.

From this point of view, the whole region of the Thetis, from the Canarian Islands to Mongolia (the old Mediterranean regions) is quite uniform; but the Eastern parts of this region, received from Africa, chiefly the desert types; while in its Western parts, besides the latter, were acclimatized less xerophyte and partly mezophytic circles of ancient African flora.

(b) During this period, very intensive exchange went between Western Eurasia (or West Africa) and North America; and as a result of this exchange, America got then from the Old World, a series of desert forms, coming over the North Atlantic, which had partly the desert climate and which probably ex-

isted up till Quarternary.

(c) In the late Tertiary and in the Quarternary, the African elements of the old Mediterranean region were subjected to considerable abatement, which in deserts was bound, in the first line, to the change of the edaphic features of the deserts; to the reduction, in consequence of destruction, by wind and water of the gypsiferous series of lower and Middle Tertiary, through which the desert plants of the Welwitschia flora were primitively spread. In the place of these gypsiferous strata, of stony deserts, the vast sandy deserts appeared, and only a few forms of the primitive desert flora were capable of being adapted to the peculiar conditions of life in these deserts. This cause, together with the destruction of the Lemurian land and with the isolation of the old Mediterranean region from South Africa, led to the isolation and to the dying out of the greater part of the types of the Welwitschia flora in the deserts of Asia and the Sahara.

In the place of these types, a new xerophytic desert flora arose; we may call it the old Mediterranean flora, or the flora of Iran. The flora of Middle Asia is a part of it.

B I B L I O G R A P H Y   A N D   R E F E R E N C E S

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